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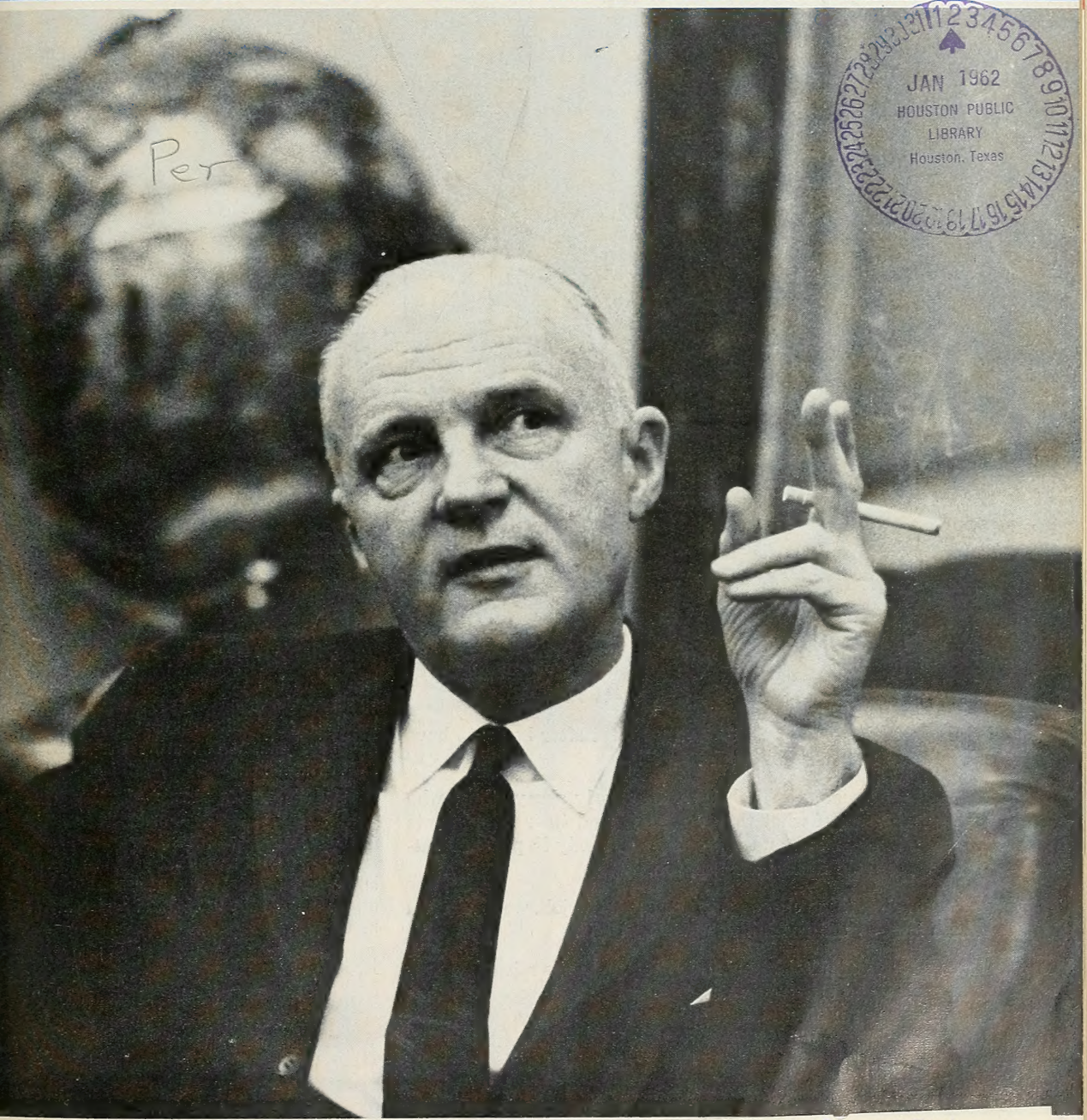
missiles and rockets

THE MISSILE/SPACE WEEKLY



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The Navy's Wakelin—New Directions in R&D

New Million-lb.-thrust Engine Planned . .
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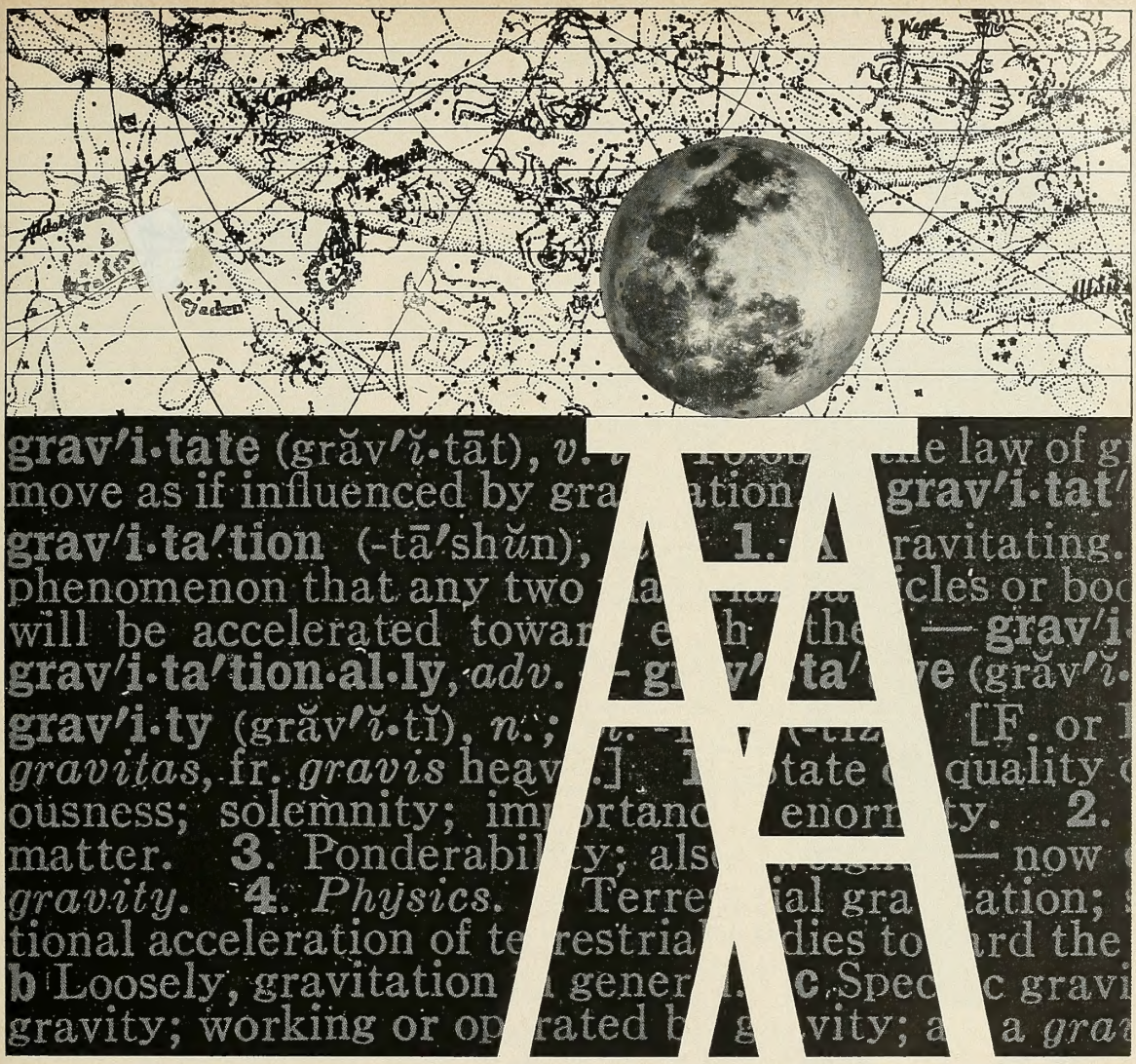

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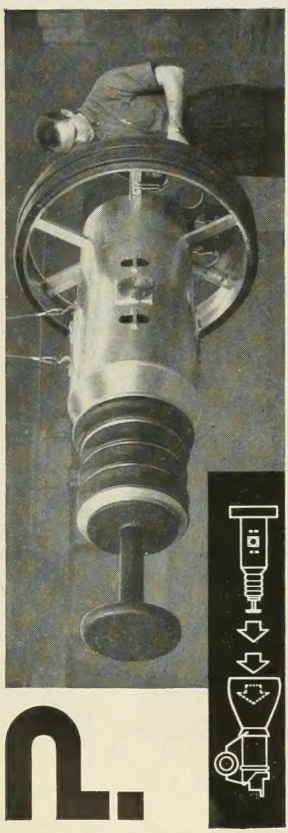

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letters

High Cost of Brevity

To the Editor:

It is with a wry degree of amusement that I note (M/R, Nov. 6) reader Graf's suggestion that you publish a much-needed "list of abbreviations," and your "Suggestion noted" implication that you may comply.

I believe that Mr. Graf has in mind a "Dictionary of Aerospace Abbreviations and Acronyms." Entry samples would include such valid terms as:

ACRE—Automatic Checkout and Readiness Equipment.

BOSS—Bioastronautical Orbital Space System.

COED—Computer Operated Electronic Display.

DOC—Direct Operating Cost.

EGAD—Electromagnetic Gas Detector.

FUR—Failure, Unsatisfactory, or Removal (report).

GERM—Ground Effect Research Machine.

HE—High Explosive.

IDA—Institute for Defense Analysis.

JAG—Judge Advocate General.

KISS—"Keep It Simple, Stupid" (or "Sir," as applicable.)

LACE—Liquid Air Cycle Engine.

MAD—Motor Assembly and Disassembly (Building, or area).

NIB—Non-Interference Basis (on a).

OAR—Office of Aerospace Research.

PIG—Pendulous Integrating Gyro.

—and so on. . .

I conservatively estimate that such an undertaking would occupy your entire organization for a period of not less than six months. Then a staff of researchers would be required to merely keep the listing up to date. However, there is a crying need for such a dictionary and I am sure your efforts would be rewarded. (A prepublication price of $5 to $7 would be about right, and you may bill me for the first copy.)

Several years ago Lear, Inc., of Santa Monica, published such a handy-dandy booklet titled "Aviation Alphabet Scoop." With this as a starter I have since accumulated several thousand additional abbreviations and terms, am about to give up the entire hobby as a hopelessly never-ending task.

If you care to use my uncollated notes as a beginning, you are more than welcome to them.

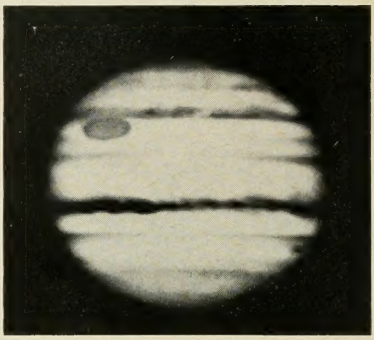
John A. Main
Woodland Hills, Calif.

Offer noted.—Ed.

Face of Jupiter

To the Editor:

Mr. Forward's article on Jupiter ("Jupiter—Probe Target After Mars," M/R, Dec. 4, p. 22) was both interesting and informative. However, the illustration depicting the band structure of the planet omitted several important features and was somewhat inaccurate. I fully realize that the diagram for such an article is not intended to be detailed and hence could accept the circular rather than the elliptical shape,



JUPITER'S spots show in 200-in. photo.

but I do feel that the following points should be noted:

1. The polar areas should be termed regions, not zones, and are actually dark rather than light.

2. The South equatorial belt is always divided by a rather prominent light strip.

3. The equatorial zone is divided by a fine dark band which Russia's S. K. Vsekhsviatsky believes to be the shadow produced by a ring similar to Saturn's but much less dense and hence unobservable.

4. Two additional temperate zones should be included.

Raymond J. Stein
Supervisor
Planetarium and Observatory
The Newark Museum
Newark, N.J.

Spies Everywhere

To the Editor:

Some readers have greeted, with joyous cries of malice, your editorial comments regarding the non-profit organizations, and at least a few of these people seem to be writing through their hats.

Mr. Kelchner (Letters, M/R, Dec. 4), for instance, fears that staff members of non-profit organizations may steal secrets from some industrial companies and peddle them to others.

Why stop there? The danger is all around us. How about *company* employees who may carry their own companies' secrets to others?

Let's go further: Consider the danger that Martian midgets may hide under the beds of scientists to record their midnight musings and sell them. Quickly, men, break out the brooms and poke under those beds. Ready? Poke!

Isn't the role of non-profit organizations in national defense worthy of intelligent, dignified examination?

Walter Golman
Washington, D.C.

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THE MISSILE / SPACE WEEKLY

missiles and rockets

Volume 10, Number 1 January 1, 1962

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THE COVER

Dr. James H. Wakelin, Jr., Assistant Secretary of the Navy for R&D, is in charge of redirecting his service's in-house research work. Special Report starts on p. 13.

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†U.S. Reg. Pdg.

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LIFT OFF . . .

Titan II inertial guidance takes a ride Nov. 29 aboard a Titan I from the Cape

The Countdown

WASHINGTON

Stumbling Block to Space

Word being passed along Pentagon corridors has it that the biggest stumbling block to military space programs continues to be the No. 1 man in the building—Defense Secretary Robert McNamara. The former Ford president is said to be still unconvinced that the time has come to start working a lot harder on some new hardware for SAC—like *Dyna-Soar*.

Biggest Budget

The Kennedy Administration's FY '63 defense budget of more than $51 billion will be the biggest in the nation's peacetime history—but it still had to undergo a last-minute hacking to keep it under an arbitrary ceiling set by the Budget Bureau. The budget probably will go to Congress around Jan. 22.

On the Pad

First manned *Mercury* orbital launch is still set for Jan. 16. . . . It will be followed within weeks by the first attempt at a lunar hard-landing with a *Ranger* capsule and the fourth of NASA's *Tiros* weather satellites.

The Push for Zeus

The Army is stepping up its drive to win approval of plans to put the big *Nike-Zeus* system into production. The three test launchings of the Western Electric anti-missile missile Dec. 14—all within one hour—is expected to be only the first of a sensational series of tests demonstrating the system's capability. The goal: Authorization of production and deployment before Congress goes home next summer.

Navy's New Missile Outlook: Blank

Although it has some new birds in the study stage, the Navy doesn't expect to move any missiles into the development stage this year. Emphasis will be on improving existing models.

INDUSTRY

Dupont to Build at Cape?

There's a report Dupont has purchased 6400 acres of land near the Cocoa-Titusville airport at Cape Canaveral and is getting ready to move into solid-propellant manufacture—presumably for big boosters. COUNTDOWN is told that the giant chemical company presently is negotiating with a small firm doing solid-fuel experimental work. The reported plan: acquire the firm, expand it and get into competition with Thiokol, Aerojet and the other big propellant producers.

Thiokol Diversifies into Plastics

In a diversification move, Thiokol Chemical Corp. is buying an industrial laminates plant from the St. Regis Paper Co.'s Panelyte Division at Trenton, N.J. Thiokol intends to expand and improve the firm's product line of sheet, tube and rod laminates for the electrical, appliance and other manufacturing industries.

Front Office Intelligence

Promoted to vice president at Aerojet-General Corp.: William C. House, director of *Nerva* operations, and Dr. Ernest R. Roberts, who has been assistant manager of the company's Solid Rocket Plant at Sacramento. . . . At Northrop Corp., F. W. Lloyd has been named assistant general manager-operations and Welko E. Gasich assistant general manager-technical—two new positions carrying vice presidential rank. . . . H. F. Konig is being moved from general manager of General Electric's Light Military Electronics Division at Utica, N.Y., to consultant to Dr. George Haller, general manager of the company's Defense Electronics Division at Syracuse. Konig is being replaced by Gerald A. Hoyt . . . and at Huntsville, "Mr. Zeus," Col. Glenn V. Crane, is leaving this month as project manager of the A-ICBM for a tour at the Industrial College of the Armed Forces.

R&D Intelligence

The Air Force is looking for a minimum three years of useful life in its gel-solid propellant being developed by Atlantic Research Corp. . . . Slippage in the *Centaur* launch program is now being attributed to the failure of several subcontracted systems to meet specs. . . . Sperry Gyro scientists have come up with quantity-production method for hexafluorobenzene, a radiation-resistant liquid which shows promise as a base for "floating" inertial guidance system components.

Patent Progress Unlikely

Resolution of the controversy over government patent policies doesn't appear in the cards for the next congressional session. The reason: The Kennedy Administration has come up with legislation which would give the government title to all patents developed by private industry under R&D contracts. The bill is expected to be defeated—leaving the status quo.

INTERNATIONAL

France's Space Program Shapes Up

France—with the creation Dec. 19 of CNES (Centre National d'Etudes Spatiales)—plans to spend about $16 million this year on space research. Half will go into domestic programs and the rest in international efforts. Spending on space is expected to rise to a yearly volume of about $30 million.

Overseas Pipeline

Belgium's first rocket motor test facility is ready for operation at Zutendaal under the government's Fabrique Nationale d'Armes de Guerre. . . . Boelkow and Focke-Wulf have finished a joint design study for the West German third stage of the projected European satellite launcher. . . . France is ready to launch a 4-stage *Berenice* research rocket in a Mach 12 nose cone test . . . and Brazil is now moving ahead with a space research program.

Apollo Subs Named

North American Aviation, prime for NASA's *Apollo* lunar spacecraft, has named four major subcontractors—all of whom worked on the original (M/R, Dec. 4, p. 15). Collins Radio will produce the telecommunications system at more than $40 million; Minneapolis-Honeywell the stabilization and control system at more than $30 million; Garrett Corp.'s AiResearch Division the environmental control system at more than $10 million; and Northrop's Radioplane Division the parachute recovery system.

Shots of the Week

The Army revealed Dec. 21 the successful intercept of a *Nike-Hercules* with a *Nike-Zeus* A-ICBM on Dec. 14 over White Sands Missile Range.

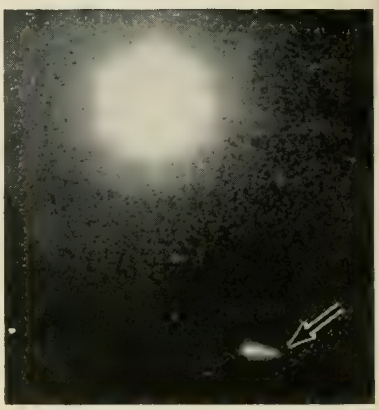
The *Zeus* missile exploded, says the Army, "well within the lethal radius" of its nuclear warhead and would have killed the *Hercules* (see photo). HE was used in the *Zeus*.

Within one hour of the test, the Army also fired *Zeus* missiles from Point Mugu, Calif., and from an underground pad on Kwajalein Atoll, which is being readied for tests against ICBM warheads later this year. The Mugu shot was described as the "longest and highest flight" of the *Zeus* to date.

In other major launchings:

• The Air Force on Dec. 18 scored its second success in a row with a *Minuteman* out of a silo. The Cape Canaveral shot went 3600 miles.

• The Air Force lost a monkey which rode 5000 miles in a capsule aboard an *Atlas* fired from the Cape on Dec. 19. However, the shot did provide telemetered measurements on neutron density which may supply data on the formation of the lower Van Allen belt.



ZEUS explodes near Hercules (arrow).

AOMC Reorganizes Missile R&D; 800 Lose Their Jobs

The Army Ordnance Missile Command—in a major shakeup—is eliminating the Army Ballistic Missile Agency (ABMA) and the Army Rocket and Guided Missile Agency (ARGMA). All missile programs are being reorganized under AOMC into 13 weapon system project offices.

The reorganization means a reduction of 800 civilians in AOMC's work force. Most of this group is expected to be absorbed into NASA's Marshall Space Flight Center at Huntsville.

Brig. Gen. John G. Zierdt—formerly commander of ARGMA—has been named Deputy Commanding General for Guided Missiles while the ABMA commander, Brig. Gen. Richard M. Hurst, has been designated Deputy Commanding General for Ballistic Missiles. Both are under AOMC commander Maj. Gen. August Schomberg.

Named to head the project offices under Zierdt were: Col. Glenn Crane —*Nike-Zeus* antimissile missile; Col. B. J. Leon Hirshorn—*Mauler* and *Redeye* air defense missile systems; Col. Harry M. Murray—*Hawk* and NATO-*Hawk;* Lt. Col. Joseph C. Baer—*Nike-Hercules* and *Nike-Ajax* and target missiles; and Lt. Col. William W. Cobb — Field Army Ballistic Missile Defense System (FABMDS).

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Two key positions are still to be filled in Gen. Zierdt's office: project manager for antitank and field artillery weapons, and a manager for tasks performed under NASA and ARPA contracts.

In General Hurst's office for ballistic missiles, the project managers include: Col. Oliver M. Hirsch—*Pershing;* Col. John E. Aber—*Sergeant;* Col. Gervase L. Barnhill—*Missile B* and Col. John T. O'Keefe—*Redstone* and *Corporal.*

Project managers for the small rockets and the *Little John* and *Honest John* weapon systems have yet to be named.

Cook Sees Big Aerospace Year

Gen. Orval R. Cook, President of the Aerospace Industries Association, predicts a steady increase in missile and space spending in 1962.

The retired Air Force Officer said that aerospace industry sales this year will equal the 1961 total of $14.8 billion, with a decline in military aircraft production offsetting the increase in missile and space activity.

He reported that sales of missiles hit an estimated $4.8 billion in Fiscal 1961.

The Securities and Exchange Commission identifies 51 companies as aerospace manufacturers. Sales of those firms increased $500 million in 1961 to a total of $13.5 billion.

Earnings of the same firms reached $240 million last year, well above earnings of $184 million in 1960.

Gen. Cook said that employment in the industry which had declined for the past several years, leveled out during 1961.

In September last year, employment totaled 673,000. It is expected to remain at about that level through 1962.

How to Build an MRBM

The Air Force appears to have chosen a piece-by-piece approach to developing a highly mobile medium-range ballistic missile (MRBM) and possibly a third-generation ICBM.

The plan apparently is to develop a new guidance system, a new motor, a new warhead—and put them together later.

Latest evidence of this includes two recent contracts—$2 million each to AC Spark Plug Div. of General Motors and General Precision, Inc.—for R&D of stellar inertial guidance and control systems for "long-range ballistic missiles."

Early last month, Hamilton Standard Div. of United Aircraft Corp. received a $1.6-million award for what the Air Force publicly described only as an "advanced stellar guidance system."

Abbott Retires from NASA

Ira H. Abbott, Director of NASA's Office of Advanced Research and Technology, will retire this week after 32 years of government service.

No successor has been named. Deputy Associate Administrator Thomas F. Dixon will double as acting director of the office.

Abbott intends to devote his full time to public affairs.

EGO To Carry Potpourri

Nineteen experiments are scheduled to be aboard the first *Orbiting Geophysical Observatory (OGO)* when it is launched in 1963.

The experiments—ranging from studies of solar cosmic rays to micrometeroid and vector velocities—will be boosted by an *Atlas-Agena B* into an eccentric orbit of 70,000 miles apogee and 170 miles perigee.

The first of the *OGO* satellite series has been dubbed *EGO,* the *Eccentric Orbiting Observatory.* Another, to be launched in 1964, will be called *POGO* because of its polar orbit flight path.

OGO is often referred to as NASA's "streetcar satellite" because it is the first standardized satellite for carrying a group of scientific experiments. Modular compartments, booms and space in the body of the observatory will be able to carry as many as 50 different experiments in any one space mission.

Three of the spacecraft are being constructed by Space Technology Laboratories Inc. NASA's Goddard Space Flight Center is managing the project.

The spacecraft is approximately 6 ft. long by 3 ft. square. The solar paddles are about 6 ft. square and the satellite—including experiments—weighs almost 900 lbs.

EGO's 19 experiments will weigh a total of approximately 150 lbs. Components of 15 experiments, weighing more than 87 lbs., are located in standard size boxes in the main body of the satellite. Components of five experiments are carried in packages at the ends of the two solar paddles.

OGO will be stabilized so that the same axis constantly points toward the earth. It will be equipped with both gas jets and reaction wheels for attitude control.

The satellite will have three telemetry systems—wide band, narrow band, and a special-purpose system—to send data back to the earth. In addition, a command system is capable of directing about 250 operations in the spacecraft and its experiments.

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New Million-lb.-thrust Engine Sought

Dyna-Soar to be 'streamlined'; Titan III funds okayed; Douglas wins Saturn S-4B award

by Hal Taylor

NASA IS PLANNING shortly to undertake the multi-million-dollar development of a new rocket engine—a 1-million-lb.-thrust, hydrogen-fueled powerplant for upper stages.

Designated the M-1, the engine is intended to be used singly or paired to produce 2 million lbs. of thrust. MISSILES AND ROCKETS has learned that the M-1 is designed as a third stage for *Nova*. There is also a possibility it may replace *Nova's* second stage, which is to be powered by two 1.5-million-lb.-thrust F-1 engines.

Disclosure of the new project caps these other major year-end moves in the nation's military and civilian space programs:

—After six months' delay, the Defense Department finally bought part of the Air Force's proposal to "streamline" the *Dyna-Soar* program by eliminating sub-orbital flights with *Titan II* boosters. But DOD officials indicated last week that there still will be no acceleration in *Dyna-Soar* funding. Only $100 million of the $185 million voted by Congress is to be used in FY '62, and there is a possibility the $100-million funding rate may be continued in FY '63.

—The Kennedy Administration approved FY '63 funds for the *Titan III*—a liquid-solid booster for *Dyna-Soar* orbital flights (M/R, June 12, 1961, p. 12).

—NASA apparently has decided that the advanced *Saturn* S-1B first-stage booster will have five E-1 engines developing total thrust of 7.5 million lbs. The second stage of this booster will have five J-2 engines developing a total of 1 million lbs. thrust. The new vehicle probably will be called the *Saturn C-5*.

—NASA awarded Douglas Aircraft Corp. a $50-million contract to build the *S-4B* third stage of the *Saturn C-5*. The stage calls for the use of a single J-2 engine developing 200,000 lbs. thrust. This will replace the earlier planned stage which was to have six RL-10 engines with a stage thrust of 90,000 lbs. (M/R, Aug. 7, 1961, and M/R, Dec. 18, 1961).

• **Contractor up in air**—The liquid hydrogen M-1 engine results from proposals from Aerojet-General Corp. and the Rocketdyne Division of North American Aviation Inc. NASA officials have not decided whether to award the contract to one of these firms or to ask all interested companies to submit bids before selecting a prime contractor.

Announcement of the new engine and the method of selecting the contractor is expected in about two weeks. Primary advantage of the M-1 will be a 30% increase in thrust per weight of the propellant over the conventional large liquid-propelled engines.

Meanwhile, Administration approval of the *Titan III* gives the Air Force its most powerful rocket to date. It will feature the unusual combination of solid and liquid fuel technology.

In the center will be the 430,000-lb.-thrust *Titan II* intercontinental ballistic missile. Clustered around it will be two or more 120-in. solid rocket motors.

The new vehicle will have a thrust of about 1.5 million lbs. if two of the solid motors are used. It would be able to hurl 14-ton payloads into earth orbit, thus approaching the capability of NASA's *Saturn C-1* launch vehicle.

A DOD announcement Dec. 26 said the Air Force would sign a new contract with Martin Marietta Corp.—developer of the *Titan II*—so that it could go ahead with initial work applicable to the new space booster system.

At the same time, the Air Force is expected in the next few weeks to invite industry proposals to build the 120-in. solid-fuel rocket motor—largest of its type in the U.S.

As the Air Force was awarded its largest space booster, NASA also moved to increase the capability of its advanced *Saturn* booster by increasing the thrust of its *S-4B* third stage.

The space agency said that the contract with Douglas provides for the development of six flight and four ground test versions of the stage.

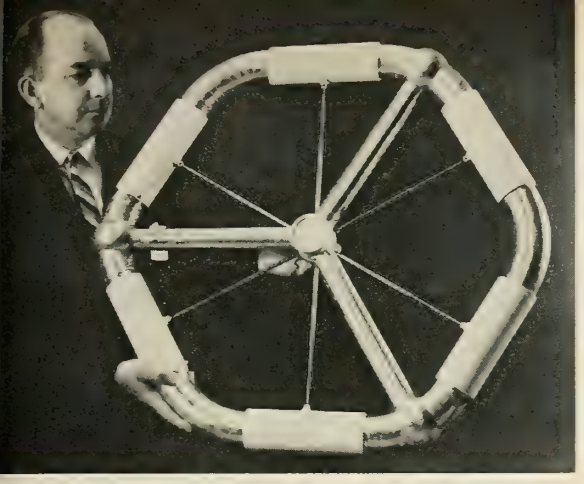
The stage will be used on the large launch vehicle when it boosts the *Apollo* spacecraft on circumlunar missions. It would also be used on orbital rendezvous missions if that concept of space flight proves feasible. If this occurs, a far larger number of the stages will be required.

NASA announced on December 20 that the Boeing Co. had been selected to build the first stage of the *Saturn C-5* booster. George H. Stoner, formerly director of its *Dyna-Soar* program, will serve as Boeing's General Manager-*Saturn* Boosters.

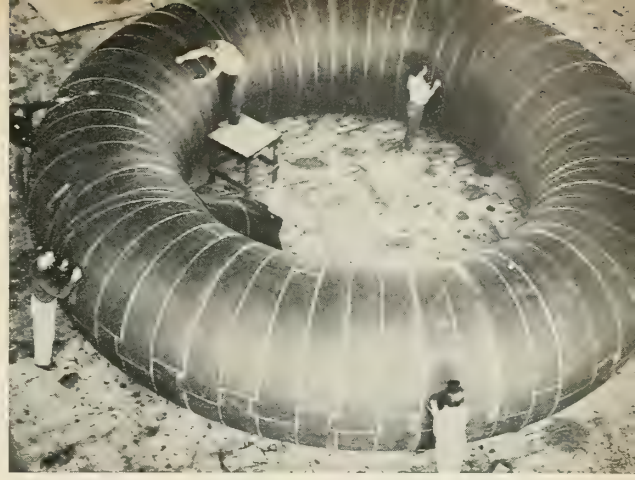
Stoner said that key members of his management team will leave shortly for NASA's Marshall Space Flight Center and the government-owned Michoud, La., operations plant to begin work on the contract.

He also said segments of his organization will be located at Cape Canaveral and at NASA's recently announced Mississippi static test-firing facility. The work at Marshall will, for the most part, be temporary and will involve familiarization, training, and liaison with NASA personnel engaged in the *Saturn* program.

Boeing planning calls for a phased buildup of its *Saturn* operations in the Southeast to require several thousand employees by mid-1963. ⌗



LANGLEY RESEARCH Center scientist holds model of the projected 15-man space station in erected condition.



PRECURSOR OF bigger space stations under consideration is this 30-ft.-dia. version built by B. F. Goodrich.

Space Agency Ponders 15-Man Station

NASA SCIENTISTS are taking a thorough look today at what could become one of America's next big space projects—a 15-man erectable space station weighing 75,000 lbs.

Administrator James E. Webb has already declared that a decision on the station will have to be made by 1965.

To meet the deadline, scientists at NASA's Langley Research Center are heavily engaged in their own basic research and have awarded North American Aviation Corp. a $100,000 feasibility study contract. Other firms, including B. F. Goodrich and Grumman Aircraft, are also taking part. Further study contracts—principally in material concepts—will be awarded next year.

NASA has been spending about $200,000 a year on the space station work. When, and if, it becomes an official NASA program, funds will likely be in the multimillion or more category.

Langley scientists hasten to assert that design and research on the space stations is still in the preliminary stage. They declare, however that "We've done a lot of work on it and it looks good."

The station could be used for conducting space research and an orbiting base for deep space missions and planetary exploration. NASA officials estimate that it could be test-flown by 1975.

• **Torus form**—The erectable concept is an outgrowth of research by Langley's Applied Materials and Research Division.

It would be structurally composed of six rigid 9-ft.-high cylindrical modules for crew quarters, joined by inflatable connector sections arranged in a torus shape.

A rigid central hub, connected to the ring by three inflatable, radial tubes, could serve as passageways when inflated and as connecting hinges between modules to form a compact package.

A fully deployed station of that design would be rotated about its hub to provide artificial gravity for the crew and instrumentation. The torus configuration would allow a diameter of 120 to 150 ft., an area necessary for an appreciable amount of gravity at low RPM. The hub of the station would be non-rotating to provide prolonged zero gravity for extended research into weightlessness.

The erectable space station would be packed into the nose of a *Saturn C-4* or *Nova* launch vehicle and would be automatically inflated in space.

The automatic erection would eliminate the necessity for having a crew assembling a number of small units launched separately into space—another method being considered for the construction of a space station. There is doubt among NASA officials that the present state of technology makes the latter concept feasible.

The space station concept could also be grounded by the theory, shared by NASA and other U.S. space experts, that a base on the moon may ultimately prove to be the best launch site for long manned interplanetary missions. Such a base is far from realization, however, and there is a strong belief that the space station could be operational a lot sooner—plus having the advantage of serving as a large laboratory for space research.

• **Multipurpose**—The space station would be compatible with both the two-man *Mercury* capsule and the *Apollo* lunar landing spacecraft. This would enable the station to have a rendezvous capability with either of the spacecraft.

The 75,000-lb. total weight—during launch—would include an *Apollo* command module re-entry vehicle.

Both the top and bottom of the station hub would serve as a port for the spacecraft on which they can dock and take off on long interplanetary missions. In addition, the station could be used as a storage area for propulsion, supplies and equipment for long manned interplanetary missions. The spacecraft would also serve as a carrier to return crew members to the earth.

The B. F. Goodrich Co. has already constructed a 24-ft.-diameter erectable station for Langley, which has used it in development work. Material used was seven miles of dacron cord.

A fibreglass wound filament with a plastic binding is also being considered. Langley scientists assert, however, that much work must still be done before a decision as to the final material for the station's outer shell is possible. They also point out that no matter what material is used, once the station is inflated, it will be as solid as metal.

Other problem areas which the NASA Center is still working include:

—The effects of radiation and meteroids on an inflated craft.

—The problems involved in "folding the material" so that it is not damaged.

—What types of structures will be most efficient.

—How to achieve thermal balance within the spacecraft so that the heat of the sun and the coldness of space can be used to provide normal temperature. ⌘

Scientist/Engineer Shortage Worsens

by Heather M. David

CONCERN is mounting at the National Aeronautics and Space Administration as the nation's force of engineers and scientists continues to shrink.

As engineering schools report lower and lower enrollments, personnel offices of the nation's space program say the demand for qualified men is skyrocketing—and will probably double within the decade.

Recent surveys show that the number of total engineers enrolled as freshmen has decreased steadily for the past four years. The drop is even more dramatic when contrasted against the total yearly increase of freshmen. An informal survey conducted by the U.S. Department of Education shows that in the period from 1953-1957, engineering freshmen accounted for about 10.5% of all incoming freshmen. This percentage dropped to 9% in 1958, 8.2% in 1959, 7.3% in 1960, and 6.6% in 1961.

Even if this percentage is bolstered by the nation's entry into the moon race, the shortage will be felt for at least four or five years as these "low" classes graduate.

It's a nice situation for those engineers and scientists armed with degrees enabling them to participate in the space program. Pay scales which already have been rising about 5% per year in the last few years will undoubtedly increase more rapidly as demand grows.

• **NASA's hiring plans**—Personnel Director Dr. Robert Lacklan says NASA is hiring about 2000 engineers and scientists in FY '62. This number will be at least repeated next year. What NASA gets from graduating college classes only meets its turnover, which is about 8% each year. (About 34% of NASA's current total of 18,000 employees are professional people.) This means that NASA must get some 1650 new engineers and scientists from other sources this year, and even more in the years to come, as its budget moves upward to a $5-billion level about 1964.

By comparison, the Air Force Systems Command, engaged in somewhat parallel work, has a work force of about 70,000 for its current budget of about $5 billion.

Competition with industry for these highly trained men is tough and will get much worse. All segments of industry—not only those connected with the missile/space field—need them. A National Science Foundation study just released says that by 1970 demand for scientific and technical personnel will have doubled.

NSF points out that scientific and engineering personnel must increase from 1,096,000 (in 1959) to about 2,032,000 in 1970—an increase of about 85,000 per year. In addition, 21,000 new scientists and engineers will be needed annually to replace those who retire, die or move to other fields of work, bring the yearly total to 106,000.

Of this, 81,000 new engineers will be needed each year—64,000 to fill new positions and 17,000 to replace old ones. But in 1960, only 37,808 bachelor degrees and 7159 masters degrees in engineering were awarded.

This year, enrollments of about 66,900 engineers are reported. But about half of each class does not make it—they flunk out, drop out, and an increasing number switch out.

• **Why the decrease?**—A number of theories have been advanced to account for the apparent drop-off of interest in engineering.

First of all, there was a general economic recession causing defense cutbacks, which did not bode well for the hiring of engineers. This began in 1957 and undoubtedly affected enrollment of engineers in 1958 and '59.

Salary Comparisons, Professional Personnel

GS Grade	Industry Rate	Government Rate
5	$ 6,576	$ 5,335
7	7,308	6,345
9	8,460	6,435
11	9,984	7,560
12	11,520	8,955
13	13,368	10,635
14	16,476	12,210
15	19,056	13,730
16	20,000/30,000	15,355
17	27,500/37,500	16,530
18	32,500/45,000	18,500

FIRST TWO grades on chart are the top salaries which government agencies may give for that grade. NASA has requested that it may offer top salaries in all other grades, which would raise each of those figures by several hundred dollars.

A great many people believe that the glamor of the physical sciences—physics, mathematics, chemistry, etc.—is attracting potential engineers. However, although there has been some little increase in these fields, it does not account for the total drop in engineering.

Another theory is that the students are steering away from engineering because they fear the hard curriculum. As we continually are reminded, it is getting harder and harder to get into and stay in college at all, because of higher enrollments and keener competition.

Some educators believe that students shy away from engineering because of the emphasis on the study of mathematics. A movement is under way to make the study of mathematics easier and more interesting. But this program must start from the early grades.

Another belief is that many capable youngsters are barred from engineering or science because of low high school grades or low IQ test grades. In fact, however, some industrial psychologists say that there is no real evidence to support the idea that grades or IQ's are measures of ability.

A study at Hughes Aircraft Co. proved that there was no correlation between success in jobs and previous grades.

• **What is being done**—The problem is obviously to encourage more high school graduates, with low or high grades, to enter engineering. NASA sponsors mailouts and displays (through the National Education Association) on space achievements, to high school science classes in the hopes of attracting young people to this field. Scholarship programs are set up for promising youngsters. NASA has let a contract to find methods of identifying potential successful people, it also is looking for such a device to apply to high school level.

Some colleges have tried to "freshen up" the somewhat dry engineering curriculum. Yale University gives a liberal arts course especially for its engineers. The California Institute of Technology sends its engineers to liberal arts schools for three years, then gives them two years of intensive engineering training. They hope this will make engineering

(Continued on page 41)

DEEP-DIVING BATHYSCAPHE Trieste in an oceanographic test run dived to 37,800 ft., the bottom of the Marianas Trench.

SPECIAL REPORT
NAVY RESEARCH

Navy Gives In-house Labs Major Role

But industry may benefit from new redirection of R&D management; FY '63's RDT&E to top $1.3 billion

by William Beller

ALWAYS STRONG . . .
the Navy's R&D Organization is taking on new importance to industry. This* MISSILES AND ROCKETS *Special Report provides fresh insight into the programs, plans and operation of the far-flung research network. On pages 16 and 17 is the first published directory of the 24 Navy in-house research facilities with budgets of more than $1 million; further on, a sample of tough problems the Navy wants solved.

THE NAVY today is charting a new course for its nationwide complex of in-house laboratories. The goal: improve and streamline technical backup for weapon systems development.

The shift could result in some real benefits to industry.

For nearly four decades, in-house laboratories have acted as consultants to the Navy—taking on assignments ranging from finding the sonar signatures of shrimp to devising high-energy propellants. Now they are being given greater responsibility in the technical direction of new programs.

This course is in line with a recent Defense Department directive designating military laboratories as "primary" instruments in weapons development. For the Navy, it means a further downgrading of extra-military organizations on the technical direction level.

The Navy is expected to ask for about $237 million for basic and applied research in the Fiscal Year 1963 budget—a 13% increase over FY '62 and evidence of the bigger role granted the laboratories. Last year, the Navy also sought a 13% hike; it obtained 12%.

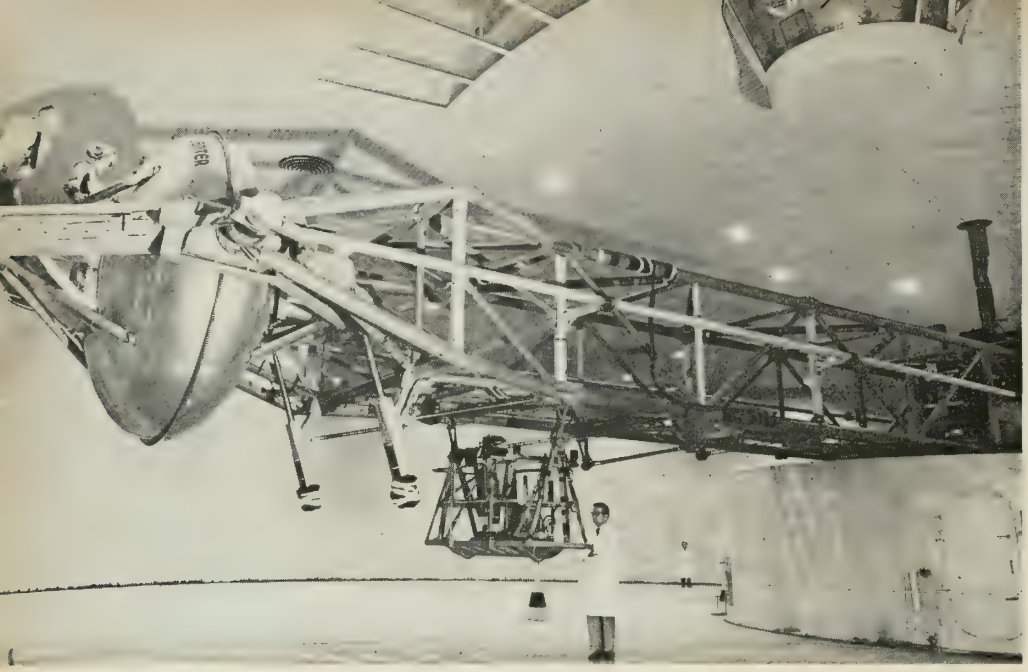
Moreover, Dr. James H. Wakelin, Jr., assistant secretary of the Navy for research and development, is firmly committed to enhancing the service's traditionally strong in-house technical capability—a capability which dates back to 1908 with the opening of the Naval Engineering Experimental Station at Annapolis, Md.

• **Looking to industry**—Wakelin, in an interview this week, predicts that the Navy's overall RDT&E budget for FY '63 will be a little higher than the $1.3 billion for FY '62.

One-third of the RDT&E total goes to Navy in-house labs and Wakelin says this ratio is "a good one." Thus, in the FY '63 budget, the labs probably will be funded at more than $400 million—including about $90 million for the Pacific Missile Range.

(Generally, 10% of a laboratory's RDT&E money goes into contracted research. The one major exception is the Naval Research Laboratory (NRL) where about 40% is earmarked for contractors.)

Wakelin is particularly concerned today with expediting research projects through in-house labs and into indus-



HUGE CENTRIFUGE at Naval Air Development Center conducts tests to learn effects of space flight on the human body. Simulated flights for X-15 pilots were made at this facility.

try. For example, he said, the oceanographic instrumentation program now has been blocked out and the specifications written. Here is an opportunity for industry to move in on the ground floor, even though initial funding is small ($1.5 million in FY '62, $46 million programed for the decade).

"They should have the job," he said. "We want them to take it. It's firm Navy policy."

On major assignments, Wakelin said, the in-house labs will be doing more technical contracting and monitoring to speed R&D into hardware.

• **Decisions on the spot**—He cited current experience in developing the Mark 46 torpedo under the technical direction of the Naval Ordnance Test Station (NOTS). Both the Navy and Aerojet-General Corp., the prime contractor, agree that sizable savings in time and money are expected to accrue as more technical decisions are made in their own backyard, without first being drawn through a Washington bureau.

At the same time, the Washington bureaus retain policy and fiscal responsibility for all Navy contracts.

On a dollar basis, only one-third of the RDT&E contracts are monitored by the bureaus, and the remaining two-thirds by in-house laboratories. "We have to have very strong and improved in-house capabilities to understand current advances in the technical art, and to take advantage of them to cut down lead time," Wakelin reasoned.

The Secretary aims to give significantly more money to the laboratories for in-house basic research—even if it means taking from other activities. Observing that the investment of relatively small amounts of money in undirected work has paid generous dividends, Wakelin advocates giving Navy scientists "more freedom to do basic research, more money for pure thinking." However, he contracted the scope of his recommendation by adding that scientists should do their thinking within the framework of the mission of the laboratory in which they're working.

In the overall picture, Wakelin says, the prime object of the Navy's 1958 management changes in RDT&E—establishment of R&D on an Assistant Secretary's level, and merging two bureaus into the Bureau of Naval Weapons—is to bring the Assistant Secretary's Office and the working laboratories closer together.

The Secretary said no new major missile projects will be started in FY '63, and he indicated that there are still enough major R&D problems to keep the service busy. "Although we're much better off in ASW than five years ago, detection and classification (of submarines) remain the big problems." He noted that the Navy has ASW leads that are showing some promise.

Navy's RDT&E Budget for FY '62

(millions of dollars)

Item	Amount (est.)	% of total
Development	$778	59
Test & Evaluaton	323	25
Applied research	142	11
Basic research	68	5
Total	$1311	100

• **RDT&E flow diagram**—The Assistant Secretary of the Navy (Research and Development) is responsible for the Navy's RDT&E program, including the appropriation.

Vice Adm. John T. Hayward, Deputy Chief of Naval Operations (Development), coordinates the operational requirements for new weapons and equipment and issues them to the Navy bureaus. He also coordinates the overall Navy RDT&E program for the Chief of Naval Operations.

The Navy's research program is coordinated by Rear Adm. L. D. Coates, Chief of Naval Research, who directs the Office of Naval Research.

Both Admiral Hayward and Admiral Coates work very closely with the Office of the Assistant Secretary for R&D.

Detailed execution of the RDT&E program belongs to the Navy's seven bureaus and offices, and the Marine Corps. A large part of the program is carried out "in house" by the Navy's laboratories and field activities. At the present time, these comprise 34 Navy-owned and operated activities and eight Navy-owned and contractor-operated facilities.

• **Why in-house laboratories?**—The in-house laboratories put the Navy's needs into a framework industry can use. This function goes far beyond rewording directives: it encompasses doing or monitoring the basic and applied research needed to show that a

pertinent idea is feasible and practical —and then helping industry develop and use it.

As an example, one segment of U.S. industry does about $16 million worth of business annually in the manufacture of a new family of high-temperature greases. The Navy holds the patents on these greases, through research done at NRL, but has granted royalty-free, non-exclusive manufacturing rights to qualifying companies.

This is one of a number of instances supporting NRL's contention that "we do not compete with industry." Dr. R. M. Page, the Laboratory's research director, maintains that "We are actually one of the greatest sources of industrial wealth in this country in terms of people and research."

He told M/R that NRL—largest of the Navy's laboratories—exists not only for the Navy but also for its contractors. "We will give free consulting service to anybody who has official need for it."

• **DOD for stronger labs** — The Navy's move to strengthen its laboratories is backed by Defense. More is involved than facilities, salaries and scientists' morale—important as they are. The laboratories' basic mission has been put into focus.

"(They) shall be used as a primary means of carrying out Defense Department programs," Defense Secretary Robert S. McNamara instructed Harold Brown, Director of Defense Research and Engineering, last October.

In view of their mission, the laboratories perform three essential services for Defense.

—They watch the advances made in the technical fields to see if any of the arising ideas can be used by the military. Moreover, they must let their technical problems be known to industry, which in turn may want to help solve them.

—They must have competent men and facilities enabling them to supply Defense with objective help in solving technical and scientific problems; must have the ability to recommend what work is to be done by industry and be able to monitor it.

—The laboratories must also act as schools to help train military officers in technical affairs.

• **Navy's reasons**—In addition to these broad reasons for wanting strong in-house laboratories, there are some hard-headed Navy ones.

—A private company may not have the facilities to do the job the service wants—and may be loath to get them because they're too expensive.

When the Navy wanted very low drag and highly stable hydrodynamic shapes for an advanced family of nuclear submarines, the only place the service could go for help was David Taylor Model Basin. This facility houses the "instant ocean," latest in a series of major new hydrodynamic facilities developed in the wake of the nuclear submarine.

Out of the Basin's work emerged the Albacore profile, which increased the maximum underwater speed of U.S. submarines so substantially that they are considered the fastest in the world today.

—Sometimes industry won't handle a job for the Navy.

"From 1947 to 1950 we couldn't get industry to even look at our problems," a highly placed bureau official told M/R. He complained about one giant research organization which "wouldn't be bothered with the Navy because the concern had so much other work to do, and besides, was reorienting itself after World War II."

—The program the Navy is preparing may be so new that the service has to do some in-house studying even to define the problems involved.

Admiral Coates points out that in 1947 no one knew that the Navy would need a long-range ballistic missile powered by solid chemical fuel. Nevertheless, ONR started a broad research program to find a family of high-energy propellants with a wide range of physical and chemical properties.

Initial study showed that a self-combustible plastic was needed; and basic chemical knowledge developed after three years of research (in-house and contracted) resulted in the nitropolymers. "The advent of a practical *Polaris* missile today has come about because of (this) research started in 1947," says the Admiral.

—Even though the facilities needed to solve some of the Navy's problems may be costly, industry might spend the money if some commercial return were foreseen, such as airplanes for the airlines; unfortunately, however, many of the service's problems are uniquely military.

The specialized facilities at NOTS helped enormously in developing the *Sidewinder* air-to-air missile. One of these facilities is an environmental test laboratory with a chamber able to simulate a climb to 50,000 feet in five minutes and a dive back to sea level in 33 seconds.

The NOTS aeroballistics laboratory uses 23 pairs of precision cameras to record the flight of objects traveling at ultrasonic speeds. And the facility has a supersonic research track four miles long for captive flight-testing of missiles, rockets and some full-scale aircraft at speeds up to 3500 fps.

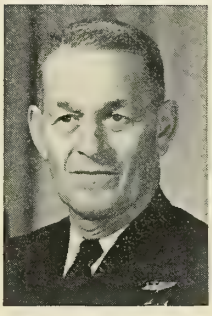
The Naval Radiological Defense Laboratory is another example of the Navy's unique facilities. It is concerned only with studying the effects of radiation on men and material, and for this purpose has a two-million-electron-volt Van de Graff accelerator as a primary source of experiments.

The Navy's extensive program in oceanography continuously calls upon the specialized talents of many of its laboratories. The Navy Electronics Laboratory has been operating the deep-diving bathyscaphe Trieste. Last July, the craft was piloted down to 37,800 ft., to the bottom of the Marianas Trench. This submergence marked the first step into a new area of oceanographic research.

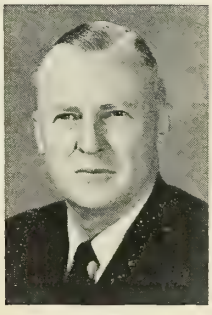
• **Almost $1 billion for oceanography**—To finance a major research effort, much of which will be handled and directed through in-house laboratories, the Navy will be pressing to get over $900 million between now and 1970 in order to learn more about the ocean. One reason for the dimensions of this effort is clear: the Navy has the tough problem of finding enemy sub-

(Continued on page 38)

WAKELIN
Assistant Navy Secretary for R&D



HAYWARD
Deputy Chief of Operations (Development)



COATES
Chief of Naval Research (heads ONR)

The Far-flung Navy Research Network

THE NAVY'S RDT&E program is carried out by seven bureaus and offices, and by the Marine Corps.

In-house laboratories act as technical consultants on the program and, on a dollar basis, monitor about two-thirds of the contracts.

Listed below are all of the Navy's in-house research facilities which have an RDT&E budget greater than $1 million.

NAVAL ORDNANCE TEST STATION, China Lake, Calif. *Commander:* Capt. Charles Blenman, Sr. *Technical Director:* Dr. W. B. McLean. *Professional Personnel:* 1230. *Mission:* Conduct research, design, development, limited production, test and technical evaluation of ordnance materials, components, assemblies and systems, principally in the fields of rockets, guided missiles, underwater ordnance, and aircraft fire control. *Budget:* $54,659,000.

NAVAL RESEARCH LABORATORY, Main Laboratory: Washington. *Commanding Officer and Director:* Capt. A. E. Krapf. *Director of Research:* Dr. Robert M. Page. *Professional Personnel:* 1200. *Mission:* Under the direction of the Chief of Naval Research, conducts scientific research and development in physical and related sciences toward new and improved materials, equipment, techniques, and systems. More than any other research establishment of the Armed Forces, the scope of NRL is broad and directed toward long-range projects. Effort is grouped into three major fields: electronics, materials, and nucleonics, with several divisions, including radar, radio, electronics, metallurgy, mechanics, atmosphere, astrophysics, and radiation, and numerous branches subordinated to these divisions. *Budget:* $41,319.000.

NAVAL ORDNANCE LABORATORY, White Oak, Md. *Commanding Officer:* Capt. W. D. Coleman. *Technical Director:* Dr. G. K. Hartman. *Professional Personnel:* 1024. *Mission:* Conduct research, design, development, test and technical evaluation of complete ordnance systems, assemblies, components and materials pertaining to existing, advance and proposed weapons, principally in the fields of missiles and underwater ordnance; conduct research in the ordnance sciences. *Programs:* NOL White Oak is the Navy's leading laboratory in the fields of aeroballistics, acoustics, explosives and magnetic materials research. It is engaged in development of missiles, nuclear weapons, mines, depth charges, fuzes (rotating), bombs, pyrotechnics and explosives. Aeroballistics facilities are used for missile research for all three services. *Budget:* $29,928,000.

NAVAL AIR MATERIAL CENTER, Philadelphia. *Commanding Officer:* Capt. J. D. Arnold. *Professional Personnel:* 433. *Mission:* Conduct research, design, development, manufacture, test and evaluation of aeronautical accessories, powerplants, air crew safety devices, equipment, structures, and materials; conduct research engineering, design, prototyping, development, limited production and maintenance of launching and recovery devices. *Budget:* $26,171,000.

NAVAL AIR DEVELOPMENT CENTER, Johnsville, Pa. *Commanding Officer:* Capt. H. L. Leon. *Chief Scientist:* Dr. H. Krutter. *Professional Personnel:* 564. *Mission:* Conduct research, design, development, test and evaluation of naval air system and components, with major emphasis on broad categories and combat air, air defense and ASW; conduct research studies in field of aviation medicine. *Budget:* $22,721,000.

DAVID TAYLOR MODEL BASIN, Carderock, Md. *Commanding Officer and Director:* Capt. J. A. Obermeyer. *Technical Directors:* Dr. Karl E. Schoenherr, Hydromechanics Lab; Dr. A. H. Keill, Structural Mechanics Lab; Dr. Harry Polacheck, Applied Math. Lab. *Professional Personnel:* 404. *Mission:* Conduct fundamental, applied and developmental research to develop: designs for naval ships which have minimum resistance, satisfactory maneuverability and maximum propulsion efficiency for given military characteristics; design propellers for naval ships and torpedoes; efficient structures of ships; such countermeasures as may be assigned; means for the protection of submarines and surface ships from the effects of underwater explosions; solve various other problems related to the foregoing, such as noise elimination and the reduction of vibration; perform developmental tests of aircraft, guided missiles, and their components to determine aerodynamic characteristics and rectify deficiencies; and operate the Applied Mathematics Laboratory in a program of research in mathematical analysis and computer techniques involving the use of high-speed automatic computing machinery. *Budget:* $21,483,000.

NAVAL AIR TEST CENTER, Patuxent River, Md. *Commander:* Rear Adm. P. H. Ramsey. *Commanding Officer:* Capt. J. Vose. *Professional Personnel:* 174. *Mission:* Test and evaluation of all Navy and Marine Corps aircraft, plus Army aircraft as may be assigned, and their components. *Budget:* $16,578,000.

NAVY ELECTRONICS LABORATORY, San Diego. *Commanding Officer and Director:* Capt. E. B. Herold. *Technical Director:* Dr. J. J. Christensen. *Professional Personnel:* 355 civilian research professionals. *Mission:* Conduct research, development, and tests in electronics and related fields of engineering and science, including radio, radar, sonar, oceanography, and instrumentation for and analysis of environmental weapons effect and human factors; and provide consultative service and sea-test facilities as authorized for the Fleet, for Navy contractors and for other agencies of the Department of Defense. *Budget:* $14,812,000.

NAVAL ORDNANCE LABORATORY, Corona, Calif. *Commanding Officers:* Capt. W. R. Kurtz, Capt. F. W. Garrison. *Technical Director:* Dr. F. Atchison. *Professional Personnel:* 4620. *Mission:* Conduct research, analysis, feasibility studies, development, design, engineering, testing, evaluation, inspection and surveillance relating to ordnance materials, assemblies, and systems principally in the field of guided missiles and related electronic devices; support the Fleet in the introduction of new weapons by providing instruction, evaluation and consultative service. *Programs:* Technical direction of the Navy's guided missile fuze research and development program; missile performance analysis, design and conduct of missile-quality assurance programs; missile counter-countermeasures development; research in infrared, solid-state polymers. *Budget:* $11,230,000.

NAVAL WEAPONS LABORATORY, Dahlgren, Va. *Commanding Officer:* Capt. T. M. Morton. *Technical Director:* Dr. R. H. Lyddane. *Professional Personnel:* 393. *Mission:* Conduct research, development, design and technical evaluation of programs dealing with weapons, ballistics, ordnance, and astronautics; serve as prime agency of the Bureau of Weapons in the field of computation and data processing. *Budget:* $9,795,000.

NAVY MISSILE CENTER, Pt. Mugu, Calif. *Commander:* Capt. K. C. Childers. *Deputy Director:* Don Sullivan. *Professional Personnel:* 180. *Mission:* Conduct test and evaluation of guided missiles, their components and weapon systems; provide services and support to PMR; provide supporting services pertaining to planning, development, evaluation and training in the field of astronautics and bio-science. *Budget:* $9,074,000.

NAVY UNDERWATER SOUND LABORATORY, New London, Conn. *Commanding Officer and Director:* Capt. B. H. Andrews. *Technical Director:* Dr. J. W. Horton. *Professional Personnel:* 222. *Mission:* Conduct research development, system studies, and engineering evaluation in the fields of sonar, radio, radar, infrared, and related physical sciences; provide technical assistance and consultation to the Forces Afloat, Naval Shore activities, including other Naval laboratories, and government contractors in problems of mutual concern. *Budget:* $8,248,000.

MATERIAL LABORATORY, Brooklyn, N.Y. *Commanding Officer and Director:* Capt. I. F. Fike. *Technical Director:* Dr. G. J. Dashefsky. *Professional Personnel:* 416. *Mission:* Conduct research, development, analytical testing, evaluation, inspection and standardization in the fields of electrical and mechanical engineering, chemistry, metallurgy, and physics, including such specialties as acoustical studies, vibration and shock, navigational instruments and gyro dynamics; provide miscellaneous materials, equipment and their installation including the testing of electronic items and certain electrical equipment, such as storage batteries for use in the propulsion of submarines; perform technical evaluation development, acceptance testing, and consulting services, including torsional vibration aboard vessels and in laboratories. *Budget:* $8,200,000.

NAVAL UNDERWATER ORDNANCE STATION, Newport, R.I. *Commanding Officer:* Capt. H. H. Brandt. *Technical Director:* Dr. G. Gould. *Professional Personnel:* 157. *Mission:* Conduct research, development, test and evaluation of underwater weapons, systems, assemblies, components and materials; receive, recondition, store and issue torpedoes, fire control subassemblies and related materials. *Programs:* Underwater ordnance-supporting research is directed toward improved propellants, back-pressure reduction devices, noise reduction, powerplant design, guidance and explosive echo ranging; in-service engineering support in fire control, launchers and torpedoes. *Budget:* $7,312,000.

NAVAL AIR TURBINE TEST CENTER, Trenton, N.J. *Commanding Officer:* Capt. N. O. Wittman. *Professional Personnel:* 61. *Mission:* Conduct tests and evaluation of aircraft gas turbine engines and their components. *Budget:* $5,449,000.

NAVAL ENGINEERING EXPERIMENTAL STATION, Annapolis, Md. *Commanding Officer and Director:* Capt. F. H. Huron. *Technical Director:* H. V. Nutt. *Professional Personnel:* 185. *Mission:* Conduct applied research, development, investigations, evaluations, and tests in the fields of physics, chemistry, metallurgy, and electricity, with respect to marine engineering equipment, materials, and processes, with particular emphasis on propulsion machinery, and its auxiliaries; investigate, analyze, and determine causes of machinery failures occurring in the Fleet and make recommendations for corrective action. *Budget:* $5,184,000.

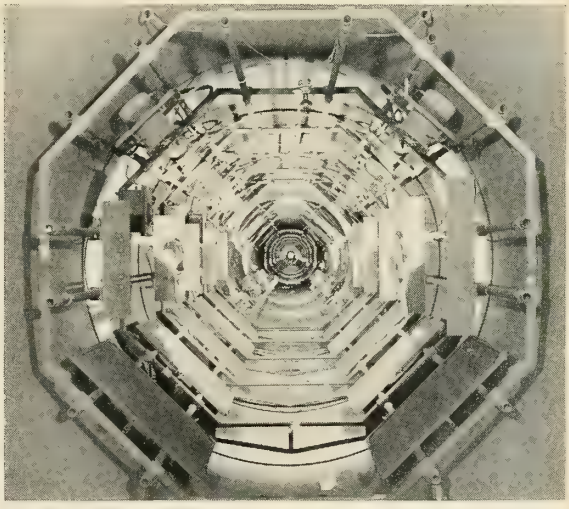
NAVY MINE DEFENSE LABORATORY, Panama City, Fla. *Commanding Officer and Director:* Capt. W. C. Bennett, Jr. *Technical Director:* Dr. Norman H. Jasper. *Professional Personnel:* 151. *Mission:* Conduct investigations, development and evaluations to provide defense against mines and torpedoes; conduct applied research in applicable related physical sciences. *Budget:* $4,348,000.

NAVAL TRAINING DEVICE CENTER, Port Washington, N.Y. *Commanding Officer and Director:* Capt. E. E. Knapp. *Technical Director:* John F. Bodenburg. *Professional Personnel:* 160. *Mission:* Develop advanced training equipment to aid naval personnel in achieving a peak of combat readiness; in addition, NTDC does much of the development for the Army's training devices and also some Air Force work. *Budget:* $4,115,000.

NAVAL RADIOLOGICAL DEFENSE LABORATORY, San Francisco. *Commanding Officer and Director:* Capt. E. B. Roth. *Technical Director:* Dr. Eugene P. Cooper. *Professional Personnel:* 237. *Mission:* Conduct basic and applied research on the physical and biological effects of hazardous nuclear and thermal radiations, including interrelated effects such as shock or blast and the dispersion and contaminating effects of fission products resulting from a nuclear explosion or from controlled nuclear processes; develop and evaluate radiac devices and shielding equipment or materials for protection of personnel, reclamation or decontamination procedures for shipboard, aircraft, and land areas; prepare data for training information required by the military services, including assistance to other federal agencies and government contractors in the fields of nuclear and radiological warfare; and develop the use of radioisotope and other tracer techniques in the above technological fields. *Budget:* $3,680,000.

NAVAL CIVIL ENGINEERING LABORATORY, Port Huenene, Calif. *Commanding Officer and Director:* Capt. Arthur B. Chilton, Jr. *Technical Director:* E. M. MacCutcheon. *Professional Personnel:* 126. *Mission:* Conduct research development and proof tests as assigned by BuDocks equipment for use at Advanced Bases and Shore Activities, and in amphibious operations; as assigned by BuDocks, develop techniques, equipment, material and structures best suited for the construction, maintenance and operation of shore and shore-type activities of the Naval Establishment. *Budget:* $3,174,000.

NAVAL MEDICAL RESEARCH INSTITUTE, Bethesda, Md. *Commanding Officer:* Capt. John R. Seal. *Technical Director:* Dr. Ralph M. Muckenfuss. *Professional Personnel:* 76. *Mission:* Conduct basic and applied research and development concerned with the health, safety and efficiency of Naval Personnel. *Budget:* $1,402,000.



VIEW INTO world's largest hyperballistic range. Located at the Naval Ordnance Laboratory, the 1000-ft.-long range tests models up to 2.5-in. diameter at speeds up to Mach 13.

NAVAL BOILER AND TURBINE LABORATORY, Philadelphia. *Commanding Officer and Director:* Cmdr. H. S. Morton. *Technical Director:* none. *Professional Personnel:* 60. *Mission:* Conduct applied research, development, investigation and full-scale tests of boilers, fuel oils, refractories, turbines, engines, reduction gears and associated auxiliary machinery and equipment comprising the main propulsion systems of ships; conduct applied research, development, investigations, and tests of specialized devices and instruments required by main propulsion systems of ships and for their sea trials; develop associated design criteria and specifications; investigate related problems in the fields of machinery, noise, vibration, and heat balance of main propulsion systems. *Budget:* $1,327,000.

NAVAL SUPPLY RESEARCH AND DEVELOPMENT FACILITY, Bayonne, N.J. *Officer-in-Charge:* Capt. Herman Strock. *Sr. Scientific Advisor:* Dr. C. S. Schoman. *Professional Personnel:* 147. *Mission:* Perform research and development in supply engineering, commissary operations and clothing and textiles; supply engineering research and development encompasses packaging, preservation warehousing, car and truck loading, shiploading, ship-to-ship cargo handling, submarine cargo handling, amphibious cargo handling, underway replenishment by helicopter, submersible fuel storage facilities, layout and design of storage spaces for types of naval vessels and test and evaluation of naval laundry equipment. *Budget:* $1,297,000.

NAVAL PERSONNEL RESEARCH FIELD ACTIVITY, Washington. *Officer-in-Charge:* Cmdr. C. F. Johnston. *Research Personnel:* 100. *Mission:* As assigned by the Chief of Naval Personnel, conducts in-service research projects, and monitors contract research, in Naval Personnel administration management. *Budget:* $1,037,000.

Basic Problems Industry Can Tackle

THE NAVY'S bureaus and laboratories are actively looking to industry for help in solving some sticky research problems.

The following list gives a sample of the pertinent problems the Navy is seeking to answer both through its own efforts and those of potential contractors.

Proposed solutions, supported by test data, should be submitted to the appropriate bureau for evaluation for possible additional study effort.

The Navy says proposed solutions should demonstrate that an answer to a specific problem is at hand or that a worthwhile approach has been sufficiently explored to show a "high probability of success."

A fuller listing and description of the research problems the Bureau of Naval Weapons wants solved may be obtained from Chief, Bureau of Naval Weapons, Department of the Navy, Washington 25, D. C., attn: Code RREN-1; and ask for NAVWEPS Report 7682, Volume 1.

There is also a secret version of the report which can be obtained with a need-to-know.

More data on the research problems of the Bureau of Ships, Medicine and Surgery, Supplies and Accounts, and Yards and Docks, can be found in a copy of "Navy Research and Development Problems," obtainable from the Chief of Naval Material, Department of the Navy, Washington 25, D.C., Attn: Code M42.

MATERIALS

PROBLEM (BuWeps): Develop O-rings and lubricants that are mutually compatible at high speeds and temperatures, or develop O-rings that do not require lubrication. Conditions of use are: a) Temperature up to 2200°F; b) Pressures up to 2000 psi; c) Rubbing speeds of 300 fps.
BACKGROUND: Many lubricants in current use are composed largely or entirely of synthetic materials. While these synthetic lubricants provide satisfactory lubrication and corrosion prevention, they have a deteriorating effect on rubber and synthetic materials.

PROBLEM (BuWeps): Develop a hydraulic fluid with the following characteristics: a) Non-flammable; b) Adequate in lubricating properties; c) Chemically stable at high temperatures; d) Chemically inert with respect to organic materials used for packing, seals, gaskets, and coatings; e) Non-toxic; f) Non-foaming; g) Possessing high viscosity index; h) Possessing low pour point; i) Possessing good heat transfer properties; j) Possessing low compressibility.
BACKGROUND: The fluids specified by the Bureau of Naval Weapons for use in hydraulic power and control systems are currently of the petroleum-base type and contain additives to improve certain of their chemical and physical properties. For example, present hydraulic fluids contain inhibitors to protect metal parts from water, but these inhibitors are not efficient corrosion preventives for long-term storage and provide only temporary protection in drained systems where only a thin film of fluid remains.

PROBLEM (BuWeps): Develop a method for coating very fine glass fibers with metal, in situ as the fibers are formed, with a high degree of adhesion between metal and glass. The metal thickness should be selective in the range 0.1 to 1 mil and the usable metals should include at least aluminum and nickel.
BACKGROUND: There is ample evidence that microscopic surface imperfections in glass fibers are a major factor in their premature failure. There is growing evidence that a tightly bonded thin metal film may minimize this deleterious effect.

PROBLEM (BuWeps): Develop thermal protection techniques to extend the use of existing primary structural materials into a hypersonic environment during sustained flight.
BACKGROUND: It is desirable to use aluminum, magnesium, and steel in airframes of Mach 10 vehicles. This necessitates development of thermal protection techniques for these metals.

PROBLEM (BuShips): Develop a technique for welding titanium to other metals, in particular, steel.
BACKGROUND: There is at present no known method for directly welding titanium to other metals. The use of an intermediate material has been suggested as a possible means to accomplish joining, but as yet no satisfactory material has been developed.

PROBLEM (BuSanda): A non-combustible impermeable coating is required for fabric to protect handlers of liquid rocket fuels and oxidizers.
BACKGROUND: Vinyl impregnated fiber glass fabrics offer inadequate protection. Modified butyl coatings give acceptable protection from penetration by corrosive liquids but support combustion.

PROBLEM (BuWeps): Develop inexpensive materials that can be used as infrared transmission elements (windows). These materials must operate in adverse missile environments involving high temperature, rapid heating and cooling, and severe vibration.
BACKGROUND: Development of infrared detectors has outdistanced development of transmission elements. The only material currently available that is satisfactory is sapphire, which is very expensive. Silicon is not suitable because it becomes opaque at temperatures incident to Mach 2 and 3 operations.

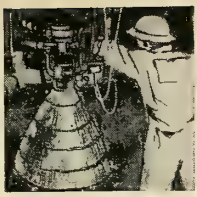
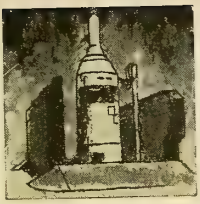
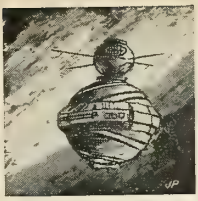
PROBLEM (BuWeps): Develop a material that is highly reflective to the light spectrum from infrared to ultraviolet, but transparent to radio frequency radiation.
BACKGROUND: The material sought has a major application in the Navy's space mission. It would be used in the fabrication of satellites.

PROBLEM (BuShips): Develop a coating material which will reduce the frictional drag of underwater vehicles such as submarines. It must be suitable for application in a shipyard, be sufficiently rugged to withstand extensive exposure to marine environment, and provide corrosion protection to the steel surfaces.
BACKGROUND: A proprietary coating system to meet the above need is currently under evaluation, but it is questionable whether it can be employed effectively on large bodies.

INSTRUMENTATION

PROBLEM (BuShips): Develop a device or method for measuring the speed of a submerged submarine with respect to the ocean bottom. Extreme accuracy at very slow speeds (1 or 2 knots) is required.
BACKGROUND: Methods are available that provide accurate indications of the speed of a vessel through the water. However, the precise underwater navigation associated with missile launching operations requires accurate ground speed information. Investigations should be lim-

(Continued on page 38)

JANUARY, 1962

ASTROLOG

rrent status of U. S. missile and space programs plus all orbiting satellites

Missiles and Rockets

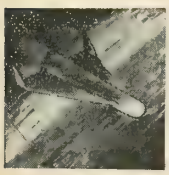
PROJECT	CONTRACTORS	DESCRIPTION	STATUS
FA (Navy)	Navy, prime; Avco, air frame	ASW surface-to-underwater; 500 lb. solid; conventional	Deployed on destroyer escorts
ROC (Navy)	Minneapolis-Honeywell, prime; Sangamo Electric, sonar; torpedo, GE; depth charge, M-H; Librascope-General Precision, fire control	Surface-to-underwater; solid rocket torpedo or depth charge; nuclear or conventional, range about 8 miles; advanced ASROC (improved Mark 44 torpedo) under R&D	Operational on Destroyers Norfolk, Adams, Dewey and Perry; plans call for deploying on 150 destroyers and cruisers
TOR (Navy)	Westinghouse, prime	ASW underwater to underwater wire-guided torpedo; nuclear	Operational
ATLAS (Air Force)	GD/Astronautics, prime; GE/Burroughs, Arma, guidance; Rocketdyne, propulsion; GE/Avco, re-entry vehicle; Acoustica, propellant utilization	ICBM; more than 5500-to-7500 mile range; liquid; nuclear; ATLAS "E" series has inertial guidance; earlier ATLAS "D" has radio inertial; proposed. ATLAS "G" would have 900,000-lb. thrust and 4000-lb. payload capability	109 launchings; 73 successes, 23 partial, 13 failures; 11 bases for 13 squadrons; operational at Vandenberg, Warren, Offutt, Fairchild and Forbes; total of 54 launchers operational, ATLAS F being tested
OMARC-A (Air Force)	Boeing, prime; IBM/Westinghouse, guidance; Aerojet/Marquardt, propulsion	Ramjet surface-to-air interceptor; liquid booster; 250 m. range; Mach 2.7; nuclear	Five bases operational in Northeastern U.S. from Virginia to Maine
BOMARC-B (Air Force)	Boeing, prime; Kearfott/Westinghouse, IBM Guidance; Thiokol/Marquardt, propulsion	Ramjet, surface-to-air; solid booster; Mach 2.7; more than 400 m. range; nuclear	Operational; a B test bird intercepted simulated target 345 miles away Oct. 14, 1960; being deployed or operational at six U.S. bases, two in Canada
ULLPUP (Navy-Air Force)	Martin, prime; Martin, guidance; Thiokol, Naval Propellant Plant, propulsion; Maxson, second-source prime	Air-to-surface; 3-6 mile range; conventional 250-1000-lb. bomb; new model has pre-packaged liquid; nuclear-tipped model nearly operational; AF designation: GAM 83-A (HE warhead), GAM 83-B (nuclear)	Deployed with Atlantic and Pacific Fleets; bigger model under R&D; soon operational with Air Force units. Marines launching BULLPUP from helicopters
OBRA (Navy)	No contract announced	Anti-ship radar missile	Early R&D
OBRA (Marines)	Boelkow Entwicklungen, West Germany, prime manufacturer; Daystrom, U.S. licensee	20.2-pound antitank missile; 1 mile range; 191 mph speed; solid propellant	Marines planning to purchase; Army considering them; already operational with West German troops
ORPORAL (Army)	Firestone, prime; Gilfillan, guidance; Ryan, propulsion	Surface - to - surface; 75-mile range; liquid; nuclear	Deployed with U.S. & NATO troops in Europe
ROW (Navy)	No contract announced	Air-to-air missile	R&D; has been flight tested

★ **Indicates changes since November, 1961, Astrolog**

PROJECT	CONTRACTORS	DESCRIPTION	STATUS
★**DAVY CROCKETT** (Army)	In-house project directed by Rock Island, Ill., arsenal	Surface to surface; solid; bazooka launched; sub-kiloton nuclear warhead; two launchers of different size for various ranges; vehicle mounted or carried by two men	Operational in Europe
ENTAC (Army)	Nord Aviation, prime	Antitank; 6600-ft. range; 37 lbs.; HE warhead; wire-guided.	Operational; Army buying from French in quantity
★**FABMDS** (Army)	GD/Astronautics, Hughes, Martin, GE, Raytheon, Sylvania—feasibility studies	Mobile antimissile defense system	Proposals under review
FALCON (Air Force)	Hughes, prime; Hughes, guidance; Thiokol, propulsion	Air-to-air; 5-mile range; Mach 2; solid; conventional; GAR-11 model has nuclear warhead	Operational; buy-out of GAR 3A, 4A and 11 in FY '62
★**EAGLET** (Navy)	No contractors announced	Cut-down EAGLE; air-to-air for use use on TFX aircraft	Study
GENIE (Air Force)	Douglas, prime; Aerojet-General, propulsion	Air-to-air unguided; 1.5-mile range; nuclear	Operational
GIMLET (Navy)	No contract announced	Air-to-surface; unguided; considered highly accurate	R&D
HAWK (Army)	Raytheon, prime; Raytheon, guidance; Aerojet-General, propulsion	Surface-to-air; 22-mile range; solid; conventional; designed to hit low-flying planes	Operational; deployed in Europe, Panama, Okinawa, U.S. (13 battalions), SUPER HAWK under development; Jan. 29, 1960 successfully intercepted HONEST JOHN, first known missile intercept of another
HONEST JOHN (Army)	Douglas/Emerson Electric, prime; Hercules, propulsion	Surface-to-surface; unguided; 12-mile range; nuclear; 5800 lbs.; ADVANCED HONEST JOHN has increased performance, lighter	Operational; deployed in Europe
HOUND DOG (Air Force)	North American, prime; Autonetics, guidance; Pratt and Whitney, propulsion	Air breathing air-to-surface; 500-mile range; Mach 1.7; turbojet; nuclear	Operational; to be launched from B-52G intercontinental bombers; stockpile expected to exceed 400
JUPITER (Army)	Chrysler, prime; Ford Instrument, guidance; Rocketdyne, propulsion; Goodyear/CTL, re-entry vehicle	IRBM; liquid; nuclear; can be made mobile	Operational in Italy (30 launchers) with Italian AF; being deployed in Turkey; 30 R&D launchings: 23 successes, 5 partials, 2 failures. 2 Italian training launches: 2 successes
LACROSSE (Army)	Martin, prime; Martin, guidance; Thiokol propulsion	Surface-to-surface; highly mobile; 20-mile range; solid; nuclear	Operational; three units deployed in Europe; more being trained; advanced LACROSSE R&D dropped
★**LAW** (Army)	Hesse-Eastern Div., Flightex Fabrics, prime	Light antitank rocket; carrier tube launcher; 4.5 lbs.; 25 in. long/3 in. diameter	In production
LITTLE JOHN (Army)	Emerson Electric, prime; Hercules Powder, propulsion	Surface-to-surface; unguided; 10-mile range; solid; nuclear	First 4-launcher battalion operational this winter
LULU (Navy)	General Mills/Naval Ordnance Lab, prime	Small nuclear depth charge air-dropped or launched by ASROC	Operational
MACE (Air Force)	Martin, prime; Goodyear/AC Spark Plug, guidance; Thiokol/Allison, propulsion	Air-breathing surface-to-surface; more than 650-mile range; turbojet & solid-nuclear; B model has more than 1200 mile range	Being deployed with U.S. troops in West Germany; new all mobile but hard-base version development completed; to be in Okinawa, Korea
MATADOR (Air Force)	Martin, prime; Thiokol/Allison, propulsion	Air-breathing surface-to-surface; 650 mile range	Being turned over to West Germans; also deployed in Far East
★**MAULER** (Army)	GD/Pomona, prime; Hughes, guidance; Lockheed, propulsion; DeHaviland, IR acquisition	Surface-to-air; radar guidance; highly mobile antiaircraft and antimissile missile for field use; on tracked vehicle; 12 missiles per launcher	R&D; NATO may buy
★**MINUTEMAN** (Air Force)	Boeing, major contractor; Autonetics, guidance; Thiokol, propulsion first stage; Aerojet, propulsion second stage; Hercules, third stage; Avco, re-entry vehicle; AMF-ACF, rail launcher	2nd generation ICBM; solid; fixed or mobile aboard railroad trains; nuclear; 3 stages	R&D; scheduled to be operational mid-1962 at Malmstrom AFB; 6 Launchings: 4 successful, 1 partial; 1 failure; tactical rail system tests completed; 3 squadrons at Malmstrom, Mont.; Ellsworth, S. D.; Whiteman, Mo.; Minot, N.D.; some 18 squadrons now planned; mobile version killed
M-55 (Army)	Norris Thermador, prime	Four-inch diameter, small, short-range poison gas rockets; to be fired from 45-tube launchers	Operational
MISSILE A (Army)	ARGMA, prime	Surface-to-surface; 10-20 mile range; solid	Design studies
MISSILE B (Army)	No contractors announced	A highly mobile general purpose missile; range 30-50 miles	Study
NIKE-AJAX (Army)	Western Electric, prime; Western Electric, guidance; Thiokol, propulsion; Douglas, airframe	Surface-to-air; 25-mile range; Mach 2.5; solid & liquid; conventional	Deployed in U.S., Europe & Far East; about 170 batteries in U.S., sixty-eight more to be phased out and replaced with NIKE-HERCULES

PROJECT	CONTRACTORS	DESCRIPTION	STATUS
NIKE-HERCULES (Army)	Western Electric, prime; Western Electric, guidance; Hercules & Thiokol, propulsion; Douglas, airframe	Surface-to-air; 75-mile range; Mach 3+; nuclear; anti-aircraft, tactical missiles; mobile or fixed	Rapidly replacing NIKE-AJAX; well over 80 batteries deployed in U.S.; more than 10 N-H batteries being deployed overseas in 1961; N-H on Formosa
★**NIKE-ZEUS** (Army)	Western Electric, prime; Bell Telephone, guidance; Thiokol/Grand Central, propulsion; Douglas, airframe	Anti-missile; 3-stage; 200-mile range; solid; nuclear	R&D test launchings at White Sands, and Pt. Mugu, 40 R&D launchings; 25 successful, 13 partial, 2 failures. First successful 3-stage launching Nov. 30, 1961; complete system tests at Kwajalein about middle of year; first ZEUS Kwajalein launching Dec. 14; 2-stage ZEUS intercepted NIKE-HERCULES at White Sands same day
★**PERSHING** (Army)	Martin, prime; Bendix, guidance, Thiokol, propulsion	Surface - to - surface; two-stage solid; approx. 500-mile range; nuclear; transported on FMC XM474 tracked vehicle; proposed PERSHING II would have 1000-mile range	R&D; to replace REDSTONE, 27 R&D launchings: 23 successes (both stages launched, guidance carried as passenger Dec. 12 for first time), 4 failures. Operational this year in Europe; W. Germany buying PERSHINGS
★**POLARIS** (Navy)	Lockheed, prime; GE/MIT, guidance and fire control; Aerojet-General, propulsion; Lockheed, re-entry vehicle	Underwater and surface - to - surface; solid; 1200-mile range can hit more than 90% all targets in Russia; nuclear; POLARIS II (1500-mile range) and SUPER POLARIS (2500 mile range) under R&D; possible A-4 4000-5000 mile range missile under study	104 launchings of test vehicles; 73 successes; 24 partial; 7 failures; 37 also launched from submerged subs—all cleared surface; 27 successful flights, 10 failures. Five subs each with 16 missiles operational. Total authorized by White House: 29 POLARIS II (A2) R&D missile successfully launched from submerged Ethan Allen Oct. 23; A2 in production
QUAIL (Air Force)	McDonnell, prime; Summers Gyro, guidance; GE, propulsion; Ramo-Wooldridge, ECM equipment	ECM-carrying bomber decoy; about 200 m. range; jet powered	Deployed at SAC bases; carried by B-52
RAVEN (Navy)	No contract announced	Air-to-surface; about 500-mile range	Study
REDEYE (Army)	GD/Pomona, prime; Philco/Convair, Atlantic Research, propulsion	Surface-to-air; 4-foot, 20-lb. bazooka-type; IR guidance; solid; conventional; container-launcher disposable	Late R&D; deployment delayed until late 1962; Marines also will use; NATO may buy
REDSTONE (Army)	Chrysler, prime; Ford Instrument, guidance; Rocketdyne, propulsion	Surface - to - surface; liquid; 200-mile range; nuclear	Deployed with U.S. troops in Europe; to be replaced by PERSHING
REGULUS I (Navy)	Chance Vought, prime and guidance; Aerojet-General, propulsion	Surface-to-surface; turbojet & solid; 500-mile range; nuclear	Deployed aboard U.S. submarines; REGULUS II used as target drone
SEMPER (Marines)	No contracts announced	Believed to be an air-launched missile	R&D testing at Pt. Mugu
SERGEANT (Army)	Sperry, prime; Sperry, guidance; Thiokol, propulsion	Surface-to-surface; solid; more than 75-mile range; nuclear	In production; DOD reported to be considering cancellation; SERGEANTS deployment in Europe in 1962
SHILLELAGH (Army)	Aeronutronic, prime	Surface-to-surface; lightweight; can be vehicle-mounted	R&D
SHRIKE (Navy)	NOTS-China Lake, prime; Texas Instruments, guidance	Air-to-surface; anti-radar; formerly called ARM	R&D
SIDEWINDER (Navy-Air Force)	GE-Philco, prime; Philco/GE guidance; Naval Powder Plant, propulsion	Air-to-air; IR guidance; more than 2 m. range; conventional; new I-C models to have switchable IR and radar-guided warheads	Deployed with Navy and Air Force; all-weather type under development
★**SKYBOLT** (Air Force)	Douglas, prime; Nortronics, guidance; Aerojet, propulsion; GE, re-entry vehicle	ALBM; more than 1000-mile range; solid; nuclear; to be launched from B-52 and Vulcan bombers	R&D; to be purchased by British; operational 1964; air drops from B-52 and Vulcan bombers successful; first "hot" launching expected in Feb.
SLAM (Air Force)	No contract announced	Surface-to-surface; low-altitude; supersonic; nuclear ramjet and warhead	Study-R&D
SPARROW III (Navy)	Raytheon, prime; Raytheon, guidance; Aerojet-General, Thiokol propulsion	Air-to-air; 5-8 mile range; Mach 2.5-3; solid and pre-packaged liquid; conventional	Operational with carrier aircraft, earlier SPARROW I obsolete; new contract extending range, altitude
★**SUBROC** (Navy)	Goodyear, prime: Kearfott, guidance; Thiokol, propulsion; Librascope-General Precision, fire control	Underwater or surface-to-underwater; 25-30 mile range; solid; nuclear	Operational aboard nuclear-powered attack sub Thresher
SS-10 (Army)	Nord Aviation, prime; GE, U.S. licensee	Surface-to-surface; primarily antitank; 1600-yards range; 33 lbs. solid; wire guided; conventional	Operational with U.S., French and other NATO and Western units; battle-tested in North Africa; U.S. Army phasing it out
SS-11 (Army)	Nord Aviation, prime; G.E., U.S. licensee	Surface-to-surface; also helicopter-to-surface; 3800-yard range; 63 lbs; wire guided; conventional	Operational, to be used with airborne units

PROJECT	CONTRACTORS	DESCRIPTION	STATUS
TALOS (Navy)	Bendix, prime; Bendix/Sperry, guidance; Naval Propellant Plant, propulsion	Surface-to-surface; 65-mile range; solid & ramjet; Mach 2.5; nuclear	Operational aboard cruiser Galveston
★**TARTAR** (Navy)	GD/Pomona, prime; Raytheon, guidance; Aerojet-General, propulsion	Surface-to-air; 10-mile range; Mach 2; 15 feet long & 1 foot in diameter; solid dual-thrust motor; conventional	Operational on 13 guided missile destroyers
TERNE (Navy)	Kongsberg Vapenfabrikk, prime; Arma, systems integration	Surface-to-underwater ASW missile; 264 lbs; HE warhead	Navy buying from Norway to equip two destroyer escorts
TERRIER (Navy)	GD/Pomona, prime; Reeves/FTL, Sperry guidance; ABL, propulsion	Surface-to-air; 10-mile range; Mach 2.5; 27 feet long; solid conventional	Operational with fleet
TERRIER-ADVANCED (Navy)	GD/Pomona, prime; Reeves/FTL, Sperry guidance; ABL, propulsion	About 100% performance improvement over TERRIER	Operational with fleet; being deployed on destroyers and carriers
★**THOR** (Air Force)	Douglas, prime; AC Spark Plug, guidance; Rocketdyne, propulsion; GE re-entry vehicle	Surface - to - surface IRBM; 1500-mile range; liquid; nuclear	Operational; 4 bases (60 launchers) set up in England. 69 military launchings: 48 successes; 11 partial; 10 failures, 65 scientific launchings: 56 successful, 2 partial; 7 failures
★**TITAN** (Air Force)	Martin, prime; Bell/Sperry, TITAN I guidance; AC Spark Plug, TITAN II guidance; Aerojet-General, propulsion; Avco, TITAN I re-entry vehicle; GE, TITAN II re-entry vehicle	Surface - to - surface ICBM; 500-mile range; liquid; 90 feet long; nuclear; TITAN I burns LOX-Kerosene; TITAN II has storable propellants, inertial guidance, bigger payload, greater range, 115 ft. long TITAN III proposed	48 launchings test vehicles: 35 successes; 9 partial; 4 failures. 8 bases for 12 squadrons planned; TITAN I scheduled to be operational mid-1961, slipped to early spring; TITAN II scheduled operational early 1963; TITAN I successfully launched from TITAN II silo; first TITAN II test early 1962; last TITAN I R&D missile successfully launched Dec. 13
TOMAHAWK (Army)	Martin, prime	Antitank	Study
★**TOW** (Army)	No contractors announced	Tube-launched, optically tracked, wire guided, HE warhead	Bids being evaluated
TYPHON (Navy)	Bendix, missile; Westinghouse, shipboard control	Medium and long range seagoing antimissile missiles; formerly called SUPER TARTAR and SUPER TALOS; solid booster and ramjet sustainer; conventional; supersonic	R&D
WAGTAIL (Air Force)	Minneapolis-Honeywell, prime	Family of airborne RLM's (rear-launched missiles): air-to-air and air-to-surface	Late R&D
WILLOW (Army)	Chrysler, prime	Highly-classified missile	R&D
ZUNI (Navy)	Naval Ordnance Test Station, prime; Hunter-Douglas, propulsion	Air - to - air, air - to - surface; solid; unguided; 5-m. range; conventional	Operational

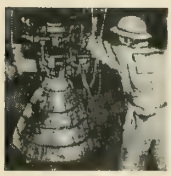


Satellites and Spacecraft

PROJECT	CONTRACTORS	DESCRIPTION	STATUS
ADVENT (Army)	Army Signal Corps, prime; Bendix prime for 24-hour satellite communications package; GE, vehicle	Twenty-four hour instantaneous repeater communications satellite; more than 1250 lbs.; program incorporates Projects STEER, DECREE and COURIER; probably will use advanced TITAN II booster	R&D; ground sites to be equipped at Ft. Dix, N.J., and Camp Roberts, Calif.; shipboard terminals also being designed; first launchings late '62
ANNA (Army, Navy, AF, NASA)	No contractors announced	Geodetic satellite; 50-100 lbs.; probably spherical	Study
AEROS (NASA)	No contract announced	24-hour weather satellite	Planning. First flights would be in 1964 or 1965; unfunded FY '62 budget; TV camera R&D to begin soon
★**APOLLO** (NASA)	North American, prime; MIT, guidance	Three-man spacecraft capable of orbiting moon or becoming space station; boosted by SATURN C-4's and probably NOVA	Earth orbital shots scheduled 1964-65; lunar orbits (unless cancelled), 1966; lunar landing, 1967-68. Propulsion and orbiting lab module contracts due before mid-62
ARENTS (ARPA)	GD/Astronautics, prime	Satellites to investigate deep space; 22,000 m. orbits; ATLAS-CENTAUR booster	Contract let to build three payloads; launchings begin early '62
ASP (Air Force)	No contracts announced	Aerospace plane, a manned spacecraft capable of operating in the atmosphere and space	Study
BAMBI (ARPA)	GD/Astronautics, STL	Satellite system capable of intercepting enemy missiles in boost phase	Studies

PROJECT	CONTRACTORS	DESCRIPTION	STATUS
CSAR (Air Force)	No contracts announced	Communications satellite system; satellites to weigh possibly two tons; to use passive lens reflectors	Studies; possibly operational mid-60's
★**DISCOVERER** (Air Force)	Lockheed, prime; GE, re-entry vehicle	THOR-AGENA and ATLAS-AGENA launchings of early stabilized satellites; main purpose is to test techniques for military space systems	Launchings: 36; 11 capsules recovered from orbit (7 air-snatched) after orbiting earth one to three days; plans to put simians in capsules scrapped.
★**DYNA-SOAR I** (Air Force)	Boeing, spacecraft and systems integrator; Martin, propulsion; Minneapolis-Honeywell, guidance; RCA, communications data link	Boost-glide orbital spacecraft; R&D leading to first space bomber; TITAN II booster; 3rd powered stage to be added	R&D; first glider flights from Edwards AFB 1962; R&D suborbital flight about early 1965; program accelerated somewhat under FY '62 budget; further acceleration through streamlining planned
ECHO (NASA)	Langley Research Center, prime	ECHO I: 100 ft. inflatable sphere in 1000 mile orbit; passive communication satellite; ECHO II: 135-ft., 700-mi. polar orbit	In orbit since Aug. 12, 1960; ECHO II scheduled to be launched 1962; suborbital tests early '62
MARINER (NASA)	JPL, prime	450 lbs unmanned spacecraft for early interplanetary missions; boosted by ATLAS-AGENA B	Seven shots planned. First scheduled Venus fly-by Aug. 1962
★**MERCURY** (NASA)	McDonnell, capsule	First U.S. manned satellite; 4000 lbs. + (capsule including escape rocket); boosters: ATLAS and TITAN II	First manned orbital flight slipped to late Jan.; 2-orbit chimp shot successful Nov. 29; new 2-man capsule program planned as part of APOLLO
★**MIDAS** (Air Force)	Lockheed, prime; Aerojet IR detector system	Early-warning satellite; detect ICBM launchings by IR before birds leave pad; R&D models weigh 2.5 tons; operational system 12-15 satellites	R&D; second launching May 24, 1960 partial success; MIDAS III successfully launched July 12; MIDAS IV successfully launched Oct. 21, detected TITAN launching Oct. 24 within two minutes of ignition
NIMBUS (NASA)	GE, integration and testing	2nd generation weather satellite; 650 lbs.; 6 TV cameras in payload; THOR-AGENA B booster	First launching scheduled for late 1962
★**OAO** (NASA)	Grumman, prime; Westinghouse, electronic components; GE, stabilization and control	3500-lb. orbiting astronomical satellite observatory equipped with telescope; boosted by SATURN	First flight scheduled in late 1963 or 1964
★**OGO** (NASA)	Space Technology Laboratories, prime	1000-lb. satellites with instruments for geophysical measurements; polar (POGO) and eccentric (EGO) shots planned; ATLAS-AGENA B, THOR-AGENA B, CENTAUR boosters	First flight scheduled in 1963; 19 experiments planned for first shot
★**OSO** (NASA)	Ball Brothers, prime	440-lb. orbiting solar observatory; THOR-DELTA booster, S-16 early version; S-17 and S-57 advanced versions	First flight planned this spring for S-16; first flight for S-17 planned for 1962
★**PROSPECTOR** (NASA)	No contract announced	Soft-landed, remote control, unmanned moon exploring or manned-lunar support spacecraft; SATURN booster	Schedule to be determined
★**RANGER** (NASA)	JPL, prime; Aeronutronic, capsule; Hercules, retrorocket	300-lb. instrumented capsule rough landed on moon; ATLAS-AGENA B booster	R&D; first two flights RANGERS failed to launch from orbit; first lunar landing planned for Jan. 1962; nine RANGERS planned
REBOUND (NASA)	No contract announced	System of 3 to 6 multi-launched ECHO II communications satellites	First orbital flight scheduled for 1963 or 1964
★**RELAY** (NASA)	RCA, prime	100-lb active repeater experimental communications satellites. Commercial system planned; DELTA booster	Britain, France, Brazil and Germany building ground stations; first launching this year
SAINT (Air Force)	RCA, prime	Anti-satellite satellite inspection system; to be complemented by interception system; about 2 tons; ATLAS-AGENA B launched	R&D; to be launched against reflectors or balloons in 400-mi. orbits
★**SAMOS** (Air Force)	Lockheed, prime	Reconnaissance satellite; formerly SENTRY; R&D model weighs 4100 lbs.	R&D; SAMOS II successfully launched Jan. 31 from Vandenberg; scheduled to be operational late 1962; advanced SAMOS under development; SAMOS III launching failed Sept. 9; satellite believed to be SAMOS IV launched Nov. 22
★**SERT** (NASA)	RCA, prime	Spinning satellite carrying two electric-propulsion engines for environmental tests	SERT I to be launched last quarter 1962 with Hughes and Lewis Center engine
SLOMAR (Air Force)	Lockheed and Martin, prime	Logistics, maintenance, supply spacecraft for space systems	Study contracts awarded in Dec., 1960
SURVEYOR (NASA)	Hughes, prime	750-lb. spacecraft soft-landing 100-300 lbs. instruments on moon; ATLAS-CENTAUR booster	First moon flights 1963; seven or more to be launched by 1965
SYNCOM (NASA)	Hughes, prime	24-hr. instantaneous repeater communications satellite. DELTA booster	R&D; first launching scheduled late 1962

PROJECT	CONTRACTORS	DESCRIPTION	STATUS
★**TELESTAR** (AT&T-NASA)	BTL, management for AT&T	125 lb., active repeater, experimental industry communication satellite; DELTA booster	R&D; two to four satellites planned; first launching scheduled in spring by NASA on cost-reimbursed basis
★**TIROS** (NASA-Wea. Bu.)	RCA, prime	Meteorological satellite; TV pictures of cloud cover; TIROS II and III carried IR scanner	R&D; first launching April, 1960; second Nov. 23, 1960; third last July 12, all successful; four more planned. Total planned 7
★**TRANSIT** (Navy)	Applied Physics Laboratory, prime	Navigational satellite; R&D model weighs more than 250 lbs.; operational model about 50-100 lbs.	TRANSIT IB R&D satellite in orbit April 13, 1960; IIA plus piggyback satellite in orbit June 22; TRANSIT IIIB launched into poor orbit Feb. 21; IVA orbited June 29 with 2 piggyback payloads that failed to separate IVB with TRAAC orbited Nov. 15; 4-satellite system scheduled to be in orbit 1962
VOYAGER (NASA)	No contract announced	Unmanned spacecraft to orbit Mars or Venus; eject capsule for re-entry; SATURN booster	Study; first flight planned by 1965
YO YO (Navy)	No contract announced	Tactical sea-launched one-pass reconnaissance satelloid	R&D
★**X-15** (NASA-AF-Navy)	North American, prime; Thiokol, propulsion	Rocket plane; 4000 mph; flight at edge of space; on AF model each XLR-11 rocket engine develops 16,000 lbs. of thrust; XLR-99 engines 50,000 lbs. Three planes delivered.	Powered flights in progress; plane #1 has hit Mach 3 and more than 136,500 ft. with XLR-11 engine; plane #2 with XLR-99 engine turned over to NASA; has hit 4093 mph speed record; altitude record of 217,000 ft. (unofficial for manned, powered flight); plane #3 flights beginning



Space Vehicles

AGENA (Air Force)	Lockheed, prime; Bell, propulsion	1700-pound satellite after burnout; AGENA B stop-start 2450-lb. engine; about fuel capacity AGENA A	Used in DISCOVERER program; larger AGENA B also to be used with ATLAS and THOR
BLUE SCOUT (Air Force)	Aeronutronic, prime; Minneapolis-Honeywell, guidance; Aerojet/Hercules, Thiokol propulsion	Solid multi-stage booster based on SCOUT components	Operational
★**CENTAUR** (NASA)	GD/Astronautics, prime; Pratt & Whitney, propulsion; Minneapolis-Honeywell, guidance	Pair of LOX-liquid hydrogen engines; 30,000 lbs. total thrust, atop ATLAS booster, capable orbiting 8500 lbs. launching 1450-lb. space probe.	First flight test slipped to late Jan. or early Feb.; first engine delivered
DELTA (NASA)	Douglas, booster; Bell, guidance; Rocketdyne/Aerojet/ABL, propulsion	Successor to THOR-ABLE; upper stage guidance; 480 lb. payload capacity	Interim launch vehicle for TIROS-ECHO; being used for other satellites and one deep space probe; 26 on order
★**NOVA-L** (NASA)	No prime announced; Rocketdyne, propulsion	Clustered 6-12 million lb. liquid propellant booster plus upper stages	R&D on 1.5 million lb. F-1 engines; vehicle contract expected to be awarded this year; F-1 test-fired 19 times at more than 1 million lbs. thrust; program partly integrated with SATURN
★**NOVA-S** (Air Force)	No contractor announced; expected to be based on Aerojet/Grand Central feasibility studies	Clustered 12-million — 20-million-lb. booster; possible alternative to NOVA-L	R&D; contracts expected to be let in 1962, delayed by committee studies
ORION (Air Force)	General Atomic	Space booster launched by series of atomic explosions	Advanced engineering studies under way; tests may be attempted with resumption of nuclear testing
PHOENIX (Air Force)	No contracts announced	Recoverable booster—possibly a modified F-1	Studies
★**ROVER** (NASA, AEC)	Aerojet, NERVA prime, Westinghouse, propulsion	First nuclear rocket: KIWI non-flying test engines and NERVA flight engines	First NERVA test flight expected 1966-67
★**SATURN** (NASA)	Marshall Center, prime and booster; Douglas and Convair, upper stages; Rocketdyne, booster and mid-stage engines; Pratt & Whitney, top-stage engines; Chrysler, prime for S-1 production; Boeing, S-1B production	Series of multistage vehicles based on 1.5-million-lb. clustered S-1 booster for C-1 version and various upper stages of LOX-liquid hydrogen engines. Early model to orbit 20,000-lb. payload; C-4 booster to have 4 clustered F-1's	First C-1 launching Oct. 27 from Cape, successful; booster with inert upper stages flew 214.7 miles, (84.8 m. apogee); two more scheduled this year; first flight with live upper stages 1963; C-4 to be used for APOLLO rendezvous
SCOUT (NASA)	Chance Vought prime; Minneapolis-Honeywell, guidance; Aerojet-General/Hercules/Thiokol/ABL, propulsion	Solid four-stage satellite launcher; 200 lb. payload in orbit	SCOUT flights in '61 completed R&D; Navy proposing SEASCOUT for seaborne surface launch, would be based on POLARIS and SCOUT
★**SPAROAIR** (Navy)	Naval Missile Center, prime	Air launched, 2 stage booster; solid; 12 ft. long; 35 lb. payload; launched from F4D; SPARROW motors used	Ten launches planned; first in successful July '62
THOR-ABLESTAR (Air Force-NASA)	STL, prime; Rocketdyne/Aerojet-General/ABL, propulsion	Three-stage vehicle, orbital capability 800 lbs. Upper stage has restart engines	THOR-ABLE phased out. Used in TRANSIT and COURIER

Satellites in Orbit

★**EXPLORER I** (30.8 lbs.) U.S. Launched 1/31/58, est. life 7-10 years. Orbits earth; perigee 217 m., apogee 1087 m., period 106.0 min. (Discovered Van Allen Belt); not transmitting.

★**VANGUARD I** (3.25 lbs.) U.S. Launched 3/17/58, est. life 200-1000 years. Orbits earth; perigee 404, apogee 2452, period 133.9; transmitting.

LUNIK I "MECHTA" (3245 lbs.) Russia. Launched 1/2/59. Believed to be in orbit around sun on 15-mo. cycle; not transmitting.

★**VANGUARD II** (20.7 lbs.) U.S. Launched 2/17/59, est. life 100-250 years. Orbits earth but is "wobbling"; perigee 313, apogee 2072, period 125.2; inclination to equator 32.87°; not transmitting.

PIONEER IV (13.4 lbs.) U.S. Launched 3/3/59. Orbits sun, and achieved primary mission—earth-moon trajectory; not transmitting.

★**VANGUARD III** (about 100 lbs.) U.S. Launched 9/18/59, est. life 50-150 years. Orbits earth; perigee 321, apogee 2307, period 129.7; not transmitting.

★**EXPLORER VII** (91.5 lbs.) U.S. Launched 10/13/59, est. life 30-40 years. Orbits earth; perigee 344, apogee 668, period 101.1; transmitting.

PIONEER V (94.8 lbs.) U.S. Launched 3/11/60, est. life forever. Orbits sun, interplanetary environment probe; completed one full orbit 1/16/61; aphelion .9951 au, perihelion .8061 au, not transmitting.

TIROS I (270 lbs.) U.S. Launched 4/1/60, est. life 50-150 years. Orbits earth; picture-taking weather satellite; perigee 429, apogee 467, period 99.1; transmitting.

★**TRANSIT IB** (265 lbs.) U.S. Launched 4/13/60, est. life 6 years. Orbits earth; perigee 229, apogee 402, period 94.7. First R&D navigation satellite. Not transmitting.

★**SPUTNIK IV** (10,008 lbs.) Russia. Launched 5/15/60, est. life 2-3 years. Orbits earth; initial perigee 188, apogee 229—changed to 191/429 on 5/19/60; last reported—perigee 160, apogee 280, period 91.6. Test of support systems, cabin, for manned space flight; attempt to return from orbit failed; payload, case and two pieces now in orbit. Not transmitting.

★**MIDAS II** (5000 lbs.) U.S. Launched 5/24/60, est. life 8-15 years. Orbits earth; perigee 299, apogee 310, period 94.2 Telemetry for IR scanning failed two days after launch. Not transmitting.

TRANSIT II-A (223 lbs.) U.S. Launched 6/22/60, est. life 50-200 years. Orbits earth, perigee 389, apogee 649, period 101.6. Transmitting.

NRL SOLAR RADIATION SATELLITE I (40 lbs.) U.S. Launched 6/22/60 with TRANSIT II-A, set. life 50-200 years. Orbits earth; perigee 381, apogee 657, period 101.6. Not transmitting.

★**ECHO I** (132 lbs.) U.S. Launched 8/12/60, est. life 2-16 years. Orbits earth; perigee 563, apogee 1313, period 116.1. First successful orbiting of passive communications satellite.

★**COURIER IB** (500 lbs.) U.S. Launched 10/4/60, est. life 200-500 years. Orbits earth; perigee 577, apogee 777, period 106.8. First successful launching of delayed active repeater satellite. Transmitting.

EXPLORER VII (90 lbs.) U.S. Launched 11/3/60 by JUNO II, est. life 20-50 years. Orbits earth, perigee 258, apogee 1410, period 112.4. Provides ionospheric measurements for communications. Not transmitting.

★**TIROS II** (280 lbs.) U.S. Launched 11/23/60, est. life 200-500 years. Orbits earth; perigee 378, apogee 461, period 98.2. Not transmitting.

★**SAMOS II** (4100 lbs.) U.S. Launched 1/31/61. Orbits earth; perigee 295, apogee 339, period 94.9. First R&D reconnaissance satellite.

VENUS PROBE (1419 lbs.) Russia. Launched 2/12/61, aphelion 1.0190 au, perihelion 0.7183 au.

★**EXPLORER IX** (15 lbs.) U.S. Launched 2/16/61. Orbits earth; perigee 466, apogee 1521, period 118.1. A 12-ft. "polka dot" balloon.

★**DISCOVERER XX** (2450 lbs.) U.S. Launched 2/17/61. Orbits earth; perigee 176, apogee 350, period 93.1. No attempt to recover 300-lb. capsule because of malfunction.

★**DISCOVERER XXI** (2100 lbs.) U.S. Launched 2/18/61. Orbits earth; perigee 145, apogee 403, period 93.5. Carried IR equipment for MIDAS program to measure background radiation from earth.

EXPLORER X (78 lbs.) U.S. Launched 3/25/61. Last known position; perigee 110, apogee 112,500, period 50.12. Optical pumping magnetometer. Position uncertain.

★**DISCOVERER XXIII** (2100 lbs.) U.S. Launched 4/8/61. Orbits earth; perigee 166, apogee 292, period 92.0 Capsule ejected in wrong direction, sending it further into space. Not transmitting.

★**EXPLORER XI** (82 lbs.) U.S. Launched 4/27/61. Orbits earth; perigee 301, apogee 1109, period 107.8. Measures gamma rays from the stars absorbed in earth's atmosphere.

TRANSIT IVA (IVA, 175 lbs., GREB III, 55 lbs.; INJUN, 40 lbs.) U.S. Launched 6/29/61. Orbits earth; TRANSIT—perigee 547, apogee 620, period 103.8. GREB-INJUN—perigee 548, apogee 619, period 103.8. Transmitting. GREB III and INJUN failed to separate after three-in-one launch.

TIROS III (285 lbs.) U.S. Launched 7/12/61. Orbits earth; perigee 457, apogee 510, period 100.3. Transmitting cloud cover weather pictures.

MIDAS III (3500 lbs.) U.S. Launched 7/12/61. Orbits earth, perigee 2084, apogee 2197, period 161.5. IR early warning satellite.

★**EXPLORER XII** (83 lbs.) U.S. Launched 8/16/61. Orbits earth, perigee 481, apogee 47,663, period 1588.8. Study Van Allen belts and energetic particles in space.

MIDAS IV (3500 lbs.) U.S. Launched 10/21/61. Orbits earth; approximately 2100 circular; period 172. IR scanning early-warning satellite. Transmitting.

WESTFORD BELT (75 lbs.) U.S. Launched 10/21/61. Orbits earth; approximately 2100 circular.

★**DISCOVERER XXXIV** (2100 lbs.) U.S. Launched 11/5/61. Orbits earth; perigee, 140; apogee, 595. Malfunction in orbit forced abandonment of usual attempt to recover capsule.

★**TRANSIT IVB** (200 lbs.) U.S. Launched 11/15/61. Orbits earth; perigee, 586; apogee, 694; period, 105.6. Carried TRAAC piggy back. Satellite is an operational prototype of the Navy's navigational satellite. Transmitting.

★**TRAAC** (200 lbs.) U.S. Launched 11/15/61 piggy-back on TRANSIT IVB. Orbits earth; perigee, 581; apogee, 701; period, 105.5. Designed to test new system of stabilization based on the earth's gravitational field. Also designed to supply data on the Van Allen belt. Stabilization test still in doubt.

★**DISCOVERER XXXVI** (2100 lbs.) U.S. Launched 12/12/61. Orbits earth; perigee, 146; apogee, 297; period, 91.7. Capsule ejected from orbit and recovered from the ocean after a record of nearly four days in orbit.

★**OSCAR** (10 lbs.) U.S. Launched 12/12/61 piggy-back on DISCOVERER XXXVI. Orbits earth; perigee, 146; apogee, 289; period, 91.6. Beams signals to amateur radio operators.

(Orbital data is latest official information as of 1200 Z, December 19, 1961)

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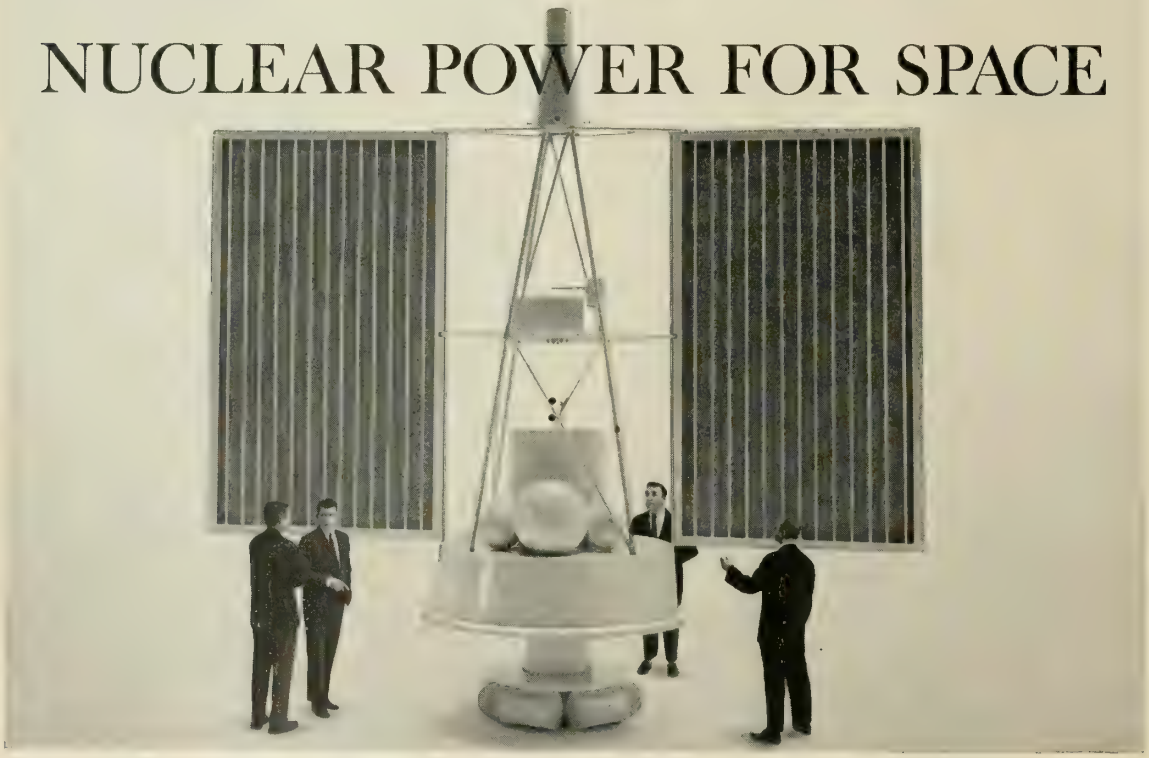

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Technical Countdown

ASTRONAUTICS

Explorer XI Data Analyzed

One of the most cherished theories of cosmologists—that matter is being continuously created in the Universe—seems to have been disproved by the data received from *Explorer XI*, according to one NASA official. The extremely low level of gamma radiation recorded by the astronomical satellite indicates, he said, that collisions between matter and anti-matter are not occurring in space—and that, therefore, it is unlikely that any matter is being created. The demise of the cosmologists' "steady-state" theory would mean new prominence for the theory of astronomers that the universe was created by an enormous explosion many billion years ago.

PROPULSION

Aerojet Racks Up Safety Record

The Liquid Rocket Plant of Aerojet-General Corp., at Sacramento, Calif., completed an entire year of operation without a single disabling injury. This means that over 6000 employees worked 13 million man-hours without a lost-time accident. One division, Manufacturing, has run since September, 1959, without an accident.

ADVANCED MATERIALS

New Tube Filament Tested

The use of rhenium with tungsten in a new alloy for radio-tube filaments can provide up to 4.5 times greater reliability, says General Electric. The extra fine wires, used in receiving tubes, reportedly are stronger and offer better heat tolerance than conventional tungsten filaments. This is the first substantial improvement in heater material since 1930, developers at G.E.'s Owensboro facility claim. Other characteristics include higher resistivity, higher "cold resistance," and less tendency to twist over under thermal stress. Present cost of refined rhenium is high—$600/lb.

Room-Temperature Laser Material Described

Calcium tungstate doped with neodymium has been investigated by scientists at Bell Telephone Labs as a material for use in optical masers. The tests, the scientists report, show that the material produces an output in the infrared and can be operated at room temperature. Input energy, they say, is only five joules.

ELECTRONICS

Bendix Likely to Get Mercury Award

The contract to operate five *Mercury* tracking stations —described as a multimillion-dollar award—appears to be headed for the Bendix Corp., NASA officials told M/R last week. Although at least three other companies have been asked for bids, Bendix—which has been operating the stations under a temporary award since July—has the inside track, space agency officials concede.

Another Space Computer in Development

A 15-lb. digital computer, dubbed PICO, is being built by Honeywell's St. Petersburg, Fla., plant. Designed particularly for space applications, the unit will permit nondestructive readout. The program is company-funded.

Gyros Considered far Attitude Control

Single-degree-of-freedom integrating gyros used as torque sources can provide very precise satellite attitude control. A recent report by Ames Research Center (NASA) indicates both advantages and disadvantages of such devices as compared with inertia-wheel control systems. Major gain with gyros is that an alternate reference is not required when the target is occulted. Gyros act as rate sensors, obviating the need for added rate stabilization networks. The big trouble is that with a 3° float angle only 5% of gyro momentum is available for active control. This creates a need for a bigger or faster turning wheel.

Armour Developing Inorganic Fuel Cell

An inorganic fuel cell—promising both high energy-to-weight ratios and very high efficiencies—is under development by the Armour Research Foundation of the Illinois Institute of Technology. The hydrogen-oxygen fuel cell uses an ion-exchanging membrane that operates at higher temperatures than an organic cell. Advantages of the device, according to Armour, are light weight, resistance to high temperature and radiation, and superior power.

Natural Language Information Retrieval

General Electric's Defense Systems Department has developed a solid-state electronic device capable of using natural language for information retrieval and dissemination. Operation is based on direct input of whole text, abstracts, or indexed information to the magnetic tape memory of the machine. The device is queried by typing in descriptions of the desired information. The output is one or more identification numbers which can be used manually or electronically to actuate further responses in a fully automated system.

Multi-Satellite Control Studied

The problems of controlling and servicing a dozen or more orbiting satellites simultaneously will be studied under a new contract to Planning Research Corp. by Lockheed-Sunnyvale. The company will investigate methods to avoid radio command conflicts and try to minimize delay in servicing satellites when they are out of radio-visible range or when ground stations over which they are passing are incapable of performing service. Optimum scheduling will be programed for digital computer direction.

Missile Accuracy Increase Possible

An angular differentiating-integrating accelerometer (ADA) has been developed which can interpret changes in relative motion and provide feedback signals to a space vehicle servo system for stabilization. In essence, it samples motion in space without effect from movement in its supporting structure. Smaller than a golf ball, the unit, General Electric designers report, will provide a 100-fold increase in missile directional accuracy.

L-T-V Space Simulator To Provid

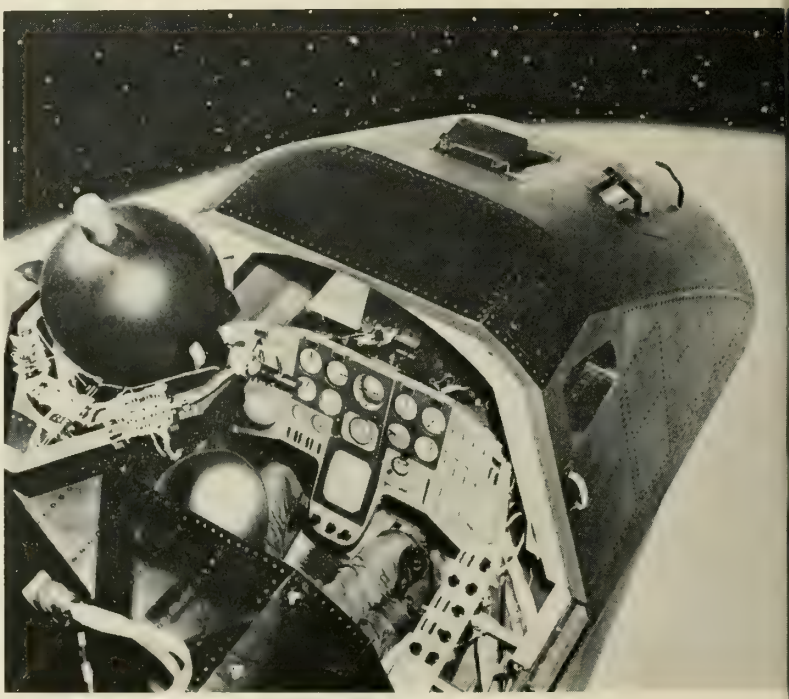
Company-funded complex is to cost over $2 million; physiological-limit tests of space pilots included

A MANNED FLIGHT simulator capable of handling virtually any type of mission in all of its phases is in operation at the Astronautics Division of Chance Vought Corp., the aerospace subsidiary of Ling-Temco-Vought.

Designed and built by the division, the simulator will be used for vehicle research and development, evaluations of various spacecraft, aircraft systems and flight techniques, and for the training of flight crews.

The unit will also be used in physiological studies of space pilots to determine the effects of the numerous vehicle and space stresses on man and his ability to function.

The cabin can simulate launch, orbit, rendezvous, mid-course guidance, re-entry, landing approach and landing. It can be adapted to perform missions related to conventional aircraft—vertical takeoff and landing, for instance.



CYLINDRICAL PROJECTOR provides the simulator pilot with this type of scene. This artist's conception illustrates what the pilot "sees" through his prism viewports. The hemispherical screen puts the pilot in space visually.

• **Space gondola** — The simulator cockpit is in a lightweight aluminum gondola attached to a moving base having three degrees of freedom around the pitch, roll and yaw axes and a pitching base capable of rotation through 180°—attitudes from full nose up to full nose down.

The pilot is restrained with a conventional lap belt and shoulder harness. His seat is a tubular frame covered with wire mesh adjustable for launch attitude and height. A wrist-action side controller handles pitch, roll and yaw as the pilot desires. Pitch and roll trim are provided by thumb wheels located atop the stick grip on the controller. Yaw trim is controlled by a thumbwheel on the left arm rest.

Two foot plates, pivotable below the arch of the foot, provide a capability for evaluating the more conventional two-axis side-stick plus rudder pedals as against a three-axis side-stick configuration.

A two-degree-of-freedom throttle is located in the wall panel above and forward of the left arm rest. Although it may be rigged for other systems, the current setup simulates control of four variable-thrust rockets mounted above, below, forward, and aft the vehicle's center of gravity.

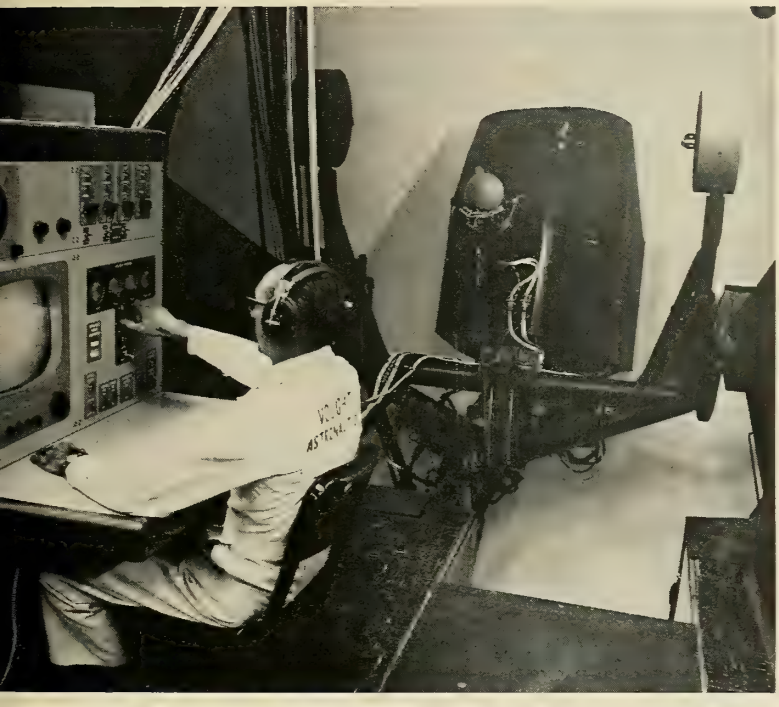
A second throttle, located immediately forward of the pilot's left hand position, increases thrust. The initial assembly simulates throttle control of an aft-firing rocket capable of changing orbital paths and retro-firing for lunar descent.

• **Myriad effects**—The cockpit display is a general-research panel aimed at providing maximum simulated space-flight capability. It includes the displays necessary to perform launch, orbit, orbit transfer, orbital rendezvous, de-orbit, re-entry, glide, landing, lunar orbit, lunar landing and lunar launch.

The displays are mechanized—some controlled from outside the gondola while others reflect the position of the simulated craft to the pilot and the effect of his control movements.

The gondola is suspended on a gimbal system. The three pivotal axes of the gimbal coincide at a point 72 in. aft of the pilot's seat. This location of the pivots corresponds to the approximate center of gravity of the simulated vehicle; hence the motion on the pilot is the proper combination of both

Realistic Manned Flight Training



GONDOLA AND WRAP-AROUND SCREEN are visible beyond the engineer at the safety console. The operating console is isolated, and the entire simulating complex including the computers costs upward of $2 million.

translation and rotation.

All motions are generated by the computer as a function of flight conditions, in order to create acceleration forces. Two types of motions are simulated.

First, when the pilot initiates a maneuver the gondola is accelerated to produce the sensation associated with entering the motion. Since the actuators are limited in stroke, the resulting accelerations cannot be sustained. A washout network in the computer integrates the gondola velocity and stroke remaining so that the acceleration is reversed soon enough to prevent hitting the stops.

The deceleration forces remain below the human feeling threshold, and the gondola is returned to its neutral position. Meanwhile, the pilot senses the initial movement, and visual sensation is continued by the external vision projection system.

The second type of motion involves unstable flight modes. The gondola oscillates as a function of the external forces about the vehicle's body axes and the aerodynamic and inertial characteristics of the simulated vehicle.

• **Miniature planetarium**—The entire gondola is enclosed in a 20-ft.-dia. fiberglass projection sphere. The projector mounted on top of the gondola projects a scene of the earth horizon and star field.

This unit is suspended in a four-gimbal arrangement, each axis of which is driven by a closed-loop electromechanical servo with unlimited freedom. One light source is fixed in the star field projector. A second light is elevated inside a cylinder whose open base creates the horizon.

A servo elevates this light source and lowers the horizon relative to the pilot's eyes as a function of the computed altitude. The depression angle to the horizon is correct from sea level to 500 miles altitude.

A shadow box covers the projector and allows only the light required to cover the pilot's field of vision. Since the sources are above the pilot's eye level and the screen a mere 8 ft. away, considerable parallax exists.

To correct this the gondola windows are designed as prisms; the pilot apparently sees the scene as directly in front.

The projected scene is always rotated relative to the longitudinal axis of the gondola and independent of all real motion of the moving and pitching bases.

In the near future, LTV will add a seat vibration system to simulate launch conditions more realistically. Taped sounds up to 120 decibels will also be incorporated. Heating elements will elevate wall temperatures up to 240°F to simulate re-entry conditions.

The entire simulator operation is directed from a master control station, which contains all the apparatus required to maintain all phases of the simulator during operation. This includes a televised picture of the pilot.

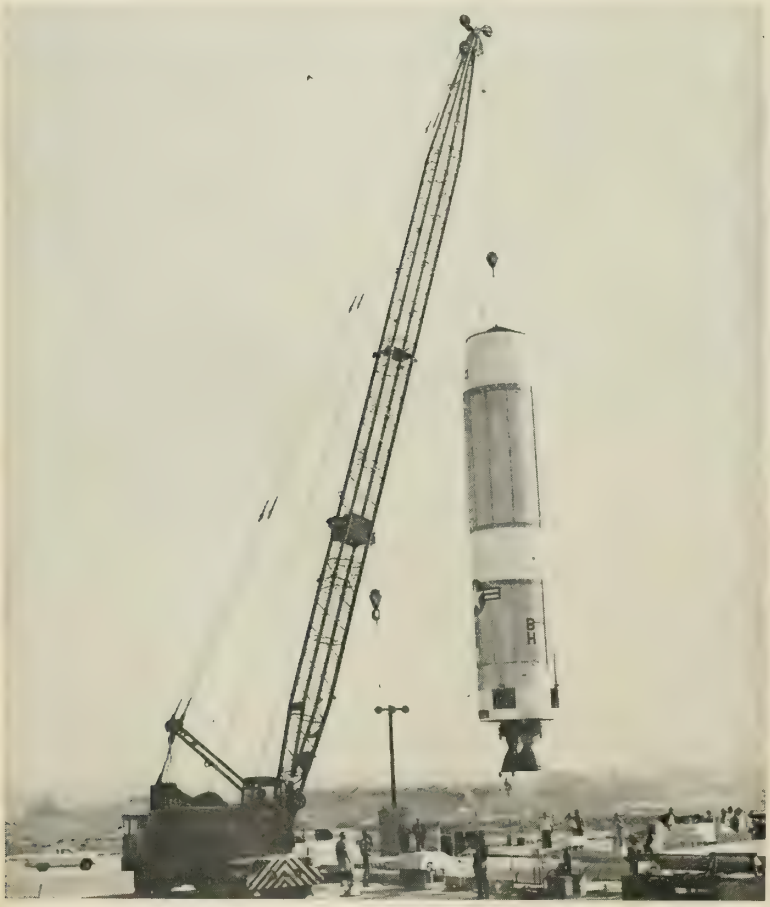
A second control console, the safety station, is also maintained during operation of the simulator to insure safe operation of the moving base.

The computer facility associated with the simulator is a general-purpose analog complex with added digital computation capability, including analog-to-digital-to-analog conversion. The general equations are considered permanent in the computer setup, but vehicle characteristics, display parameters and control system configuration are readily changed. ⌘

Unique Crane Plants Titans in Silos

British-designed machine built by Unit Crane & Shovel is only gasoline-electric truck crane produced in U.S.; electrical drive satisfies extreme precision requirement

by James Trainor



LOWERING TITAN ICBM into its underground silo requires the precise positioning of load provided by this unique gasoline-electric truck crane from Unit Crane.

PUTTING AN ICBM in its silo calls for a combination of sheer lifting power and delicacy not commonly found in commercial heavy-duty cranes.

The Air Force is using a unique British-designed crane to place the *Titan I* missile in its hardened, underground launcher—and plans to use the machine to emplace *Titan II's* as they become operational.

Its U.S. builders, the Unit Crane & Shovel Corp. of Milwaukee, say the primary advantage of the crane is its ability to provide close-tolerance positioning of a missile. This precision is possible because all of the crane's motions are electrically, rather than mechanically, driven.

• **Overall characteristics**—The machine is built in this country under license from Coles Cranes, Ltd., of Britain, and marketed under the name UNIT-COLES. Its 110-ft. boom is constructed of heavy tubular steel, in contrast to the lighter angle construction of most heavy cranes. The heavy structure is necessary because part of the lift load is supported from a hook located about two-thirds of the way down from the end of the boom.

Fully erected and ready for operation, the crane weighs nearly 99,000 lbs. However, to meet highway load limitations and increase mobility, the traveling weight of the machine can be reduced to 63,000 lbs.—just inside the rig limits of 32,000 lbs. per tandem axle set by most states. The reduction is accomplished by removing part of the crane boom, the outrigger boxes and beams, screw jacks and the counterweight—a process requiring about 30 minutes.

Using the standard rating system for crane capacity, the UNIT-COLES lifting power is set at 30 tons.

• **Electrical drive system**—The only gasoline-electric truck crane built in the U.S., the missile-lifting machine derives power for each of its individual motions from a variable-speed, series-wound

motor. Due to the characteristics of this type of motor—particularly, its tendency to slow down with increasing load—accurate control can be maintained over the load-hoist, boom-hoist or swing motions, or any combination of these.

Powering these motors is a variable voltage generator which in turn is coupled to the crane's gasoline engine. The generator acts as a torque converter and, since infinitely variable speed control is obtained without clutches, it allows precise and continuous power to flow to the motor-driven crane motions.

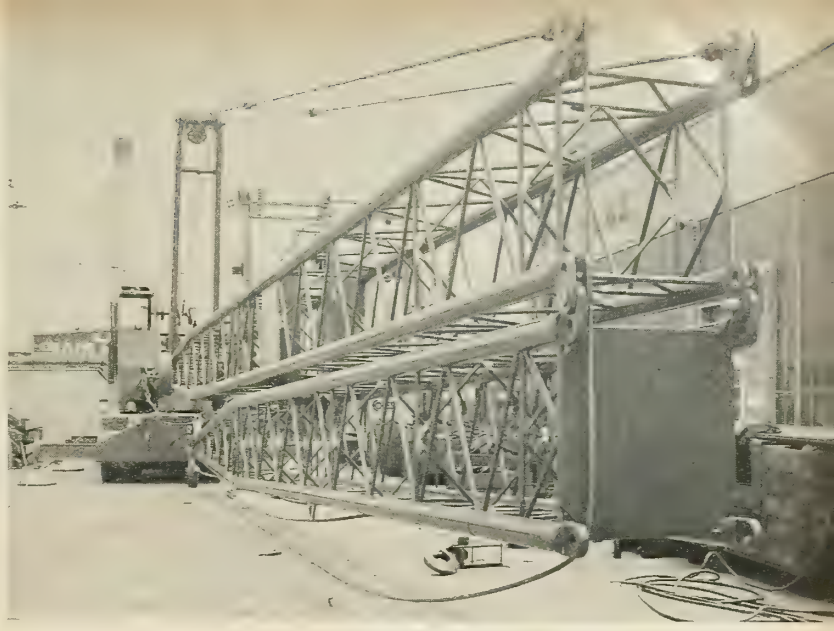
• **Safety prime concern**—One of the main considerations in handling million-dollar missile packages such as the *Titan* is safety—not only of the operator and launch site personnel but also of the load itself. Multiple safety devices have been incorporated into the design of the machine.

Dangerous load conditions resulting from too great a boom radius, for example, are sensed by an Automatic Safe Load Controller. When an operator begins to boom out beyond a safe distance for a particular load, the machine warns him by means of a blinking yellow light in the cab of the machine. If the operator ignores this warning and continues to move outward with his load, the safe load controller automatically stops and holds the boom and load hoist motions. At the same time, an alarm bell begins ringing and a flashing red light comes on. The operator cannot move the load any further out and is forced to reverse his motion until he has brought the load back well within a safe working radius.

A second safety feature is provided by limit switches which restrict maximum and minimum boom working angles. "Dead man" control is achieved by positive-action spring-loaded switches with which the operator engages all crane motions. If a switch is released for any reason, the crane motion comes to a halt.

Safety is also provided by the requirement that the generator voltage be below operating level before motion can be engaged. Hence snatching of the load is prohibited. Electromechanical brakes are constructed so that they are in a normally applied position. When an operating motion is engaged, electromagnetic coils release the brakes. Consequently if a current failure should occur, the spring-loaded brakes would be instantly reapplied.

• **Lightweight remote controller**—Since the crane is electrically driven, it is possible to use a remote control unit rather than restricting the operator to a position in the cab of the crane where his vision may be limited because of distance from the load. Therefore a 4-lb., 7-oz. remote control unit is used with the silo-loading crane to enable the operator to be as close to the missile operation as necessary.



SHORT-DISTANCE mobility is provided by folding upper section of crane under lower and locking the two together. Wheels on boom are bolted on after folding.

With this lightweight device, the operator can control all of the crane's motions from anywhere in the silo area and even from the bottom of the silo itself. The same safety measures are, of course, present in the remote operation.

• **System operation**—The first stage of the *Titan* is picked up from its transporter by using both of the lifting hooks. Then, by hauling in upper lifting hook cable and letting out the lower, the booster is gradually brought to a vertical position. It is lowered into the silo by the operator using the remote control unit.

REMOTE CONTROL unit allows operator to control load from anywhere in launch area.

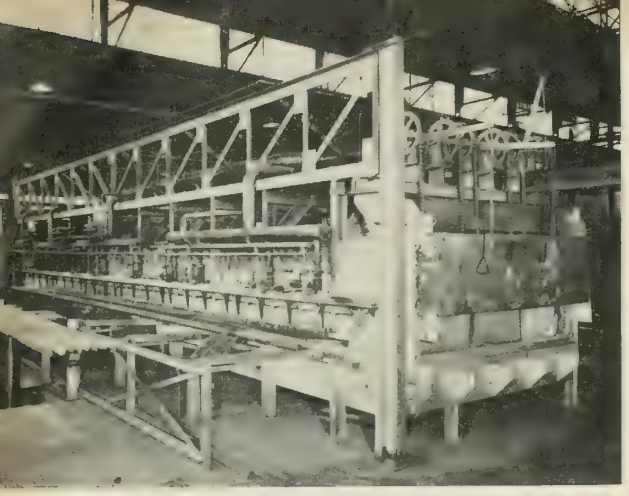
At the bottom of the silo, the load is stopped and four men position spikes located inside the booster over four holes drilled in the launcher. The booster is then lowered to its final position.

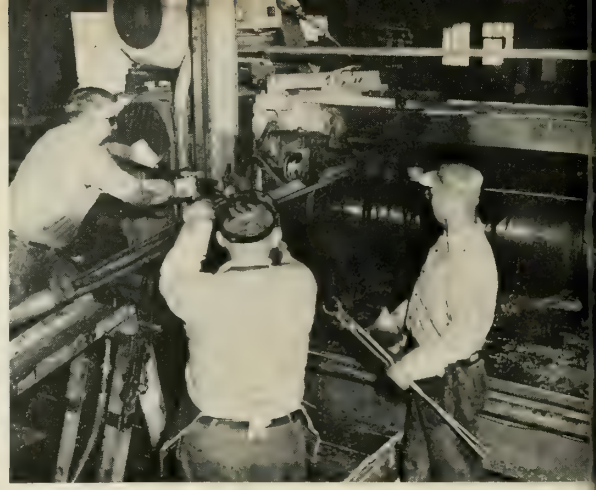
The second and successive stages are handled in essentially the same way except that, in these cases, precise positioning is required to allow mating of these units to the booster.

For short-distance travelling, the crane is not disassembled. Rather the boom is lowered and two hinge pins—located approximately half-way up the crane boom—are removed. Then, as the boom is raised again, the upper section folds in and under the lower. Wheels are then bolted to the face of the folded section and the sections are locked together. (Later models of the crane will have these wheels built in to save time).

The crane, once the outriggers and jacks are pushed back into their storage position, is ready to move to the next silo locations. The entire boom-folding process requires about 12 minutes.

• **Wide acceptance**—Already standardized for the *Titan I* application, the machine is expected to be used in the *Titan II* program. In addition, hundreds of UNIT-COLES machines are being used throughout the country by such companies as General Dynamics/Astronautics, Boeing, Hercules Powder Corp., Thiokol Chemical Co., Douglas—and, of course, the prime contractor for *Titan* support equipment, American Machine & Foundry. ⌗





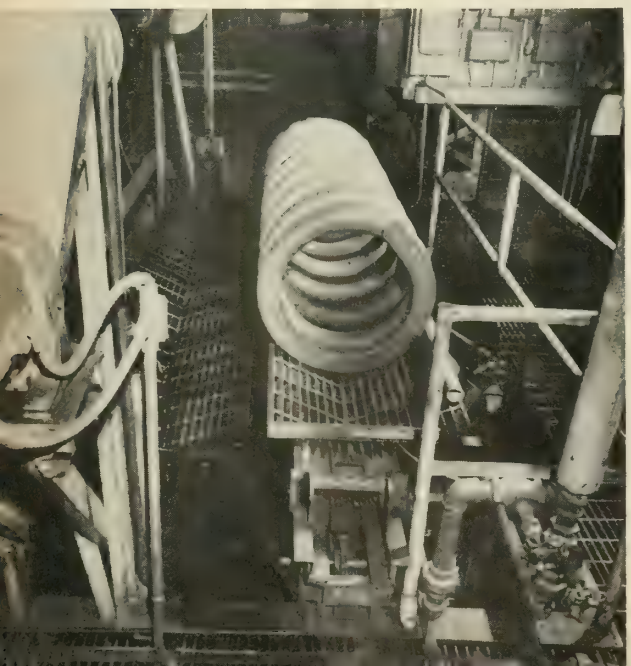
LEFT: *After tapering, the bars are placed on a conveyor which feeds them into a furnace. Over 40 feet long and with a hearth area greater than 500 square feet, the furnace uniformly heats the bars to a maximum temperature of 1700°F, then discharges them for the coiling operation.* **RIGHT:** *The machine performing the coiling operation resembles a large lathe, with the coiling mandrel occupying the position normally assumed by the work piece. The coiling guide or eye which determines the pitch of the coils can be compared to the tool post; it is geared to move longitudinally at a prescribed feed.*

In the coiling operation, the bar is pulled out of the end of the furnace and fed through the coiling guide to the mandrel, where the bar is mechanically dogged to the mandrel and against the headstock. As soon as the mandrel is rotating, the coiling guide begins to move away from the headstock end, feeding the hot bar onto the mandrel at the prescribed pitch.

missile support

Biggest Coil Springs Hold Titan II

Atlas F's also suspended in Hammond Div. half-ton aircraft-quality coils, nested in groups of four; an exclusive report



CHICAGO—"The largest coil springs in the Free World"—to hold *Titan II* missiles suspended and virtually shock-free in their silos are now being manufactured at the Hammond Division of American Steel Foundries.

Weighing nearly 1000 pounds each and measuring over 14 inches in diameter and 56 inches free height, the springs are nested in groups of four on each of the four struts holding the ICBM in readiness.

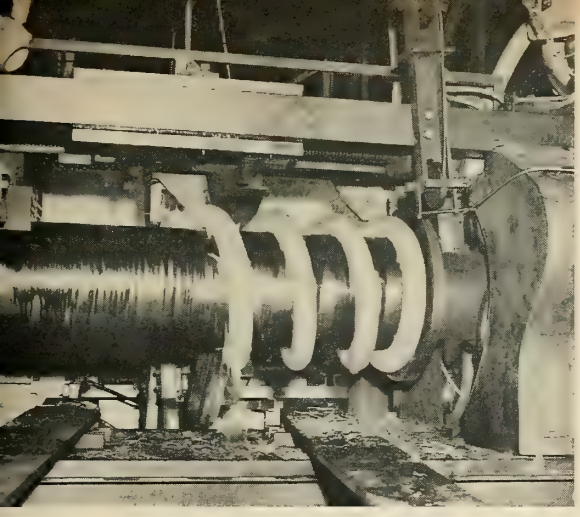
Atlas F, as well as *Titan II*, suspension springs are made at Hammond with the same manufacturing procedure shown pictorially here.

Titan II springs must be matched so that the load rate of each strut within the silo is within one percent of any other strut. To meet this as well as reliability requirements, metallurgists selected as a material a modified 4160 (increased molybdenum) aircraft-quality, fine-grained, turned, ground and polished steel, with an as-quenched hardenability of Rockwell C-50 at the center.

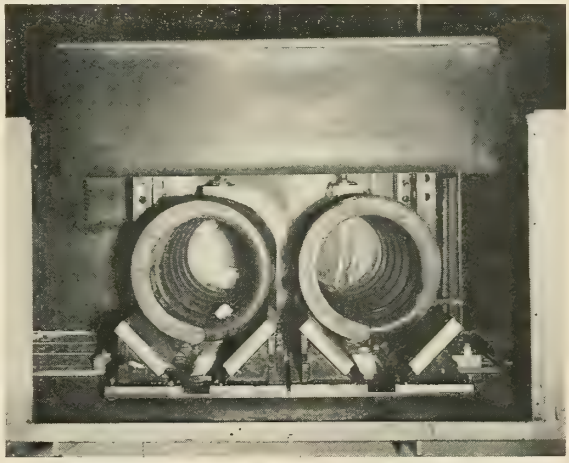
First step in forming the spring is to taper its ends into a wedge shape, in order to give the spring firm bearing areas on its extremities. In this operation, the end of the bar is heated to forging temperature (about 1900°F) and inserted between two rotating eccentric rolls which squeeze out the proper taper. ⁂

LEFT: *The spring is quenched directly after coiling, a unique procedure for a spring so large. Advantage is that a reheating operation, which would introduce insulating scale and added decarburization, is eliminated; this results in the quenching of a relatively free-bar surface and hence produces a more uniform microstructure.*

To effectively and uniformly quench the spring, the quenching oil in the tank—seen below the left-hand cradle—is maintained at a specific temperature and is kept at a high degree of agitation.



LEFT: *A unique feature of the coiling operation is that the entire coiling machine is set on tracks and is geared to move longitudinally in the headstock direction while the spring is being coiled. Thus the uncoiled bar does not move longitudinally but only into the coiling machine. Also, the bar is always fed through the coiling guide and onto the mandrel at the same angle. As a result, the friction values remain fairly constant, resulting in a uniform pitch.* **RIGHT:** *After the coiling operation, the mandrel is withdrawn through the tail stock, freeing the spring and allowing it to roll into an adjacent conveyor. The spring is scanned by an electric eye, which triggers quenching if the spring steel is at an appropriate temperature.*



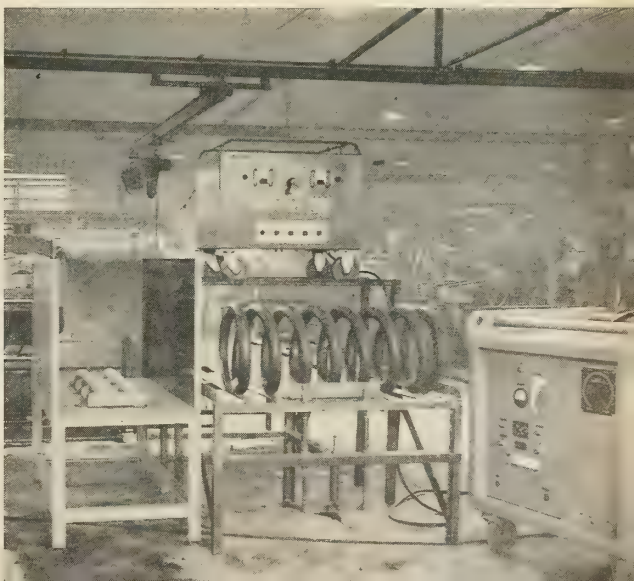
RIGHT: *After tempering, the spring is preset a minimum of six times in a large press. In this operation, a load equivalent to 125% of the solid capacity of the spring is applied, closing all coils firmly solid. The spring takes a permanent set and its free height is stabilized so that subsequent overload compressions will not result in further loss in height.*

The next operation is grinding the spring ends to insure getting a true, flat bearing surface. Two springs at a time are clamped in "V" blocks attached to a carriage, which is oscillated back and forth against a 48-inch grinding wheel. A water-emulsion coolant is kept flowing on the working to avoid overheating.

Silo Strut-Springs Specifications

Missile	Titan II	Atlas F*
No. suspension struts/silo	4	8
No. springs per strut	4	~14 (6 large, 6 intermed., 2 inner)
Outside dia. (in.)	14.25	21.75, 14.75, 9.31
Inside dia. (in.)	8.25	15.75, 10.38, 6.47
Bar dia. (in.)	2.99	3, 2, 1.25
Free height (in.)	56.5	48, 47, 46
Solid height (in.)	41.4	22.8, 21.6, 20.6
Solid Capacity (lb.)	98M	68.8M, 30.7M, 12.1M
Solid stress (kpsi)	158	162, 160, 150
Load rate (16/ir '	6500	2730, 1210, 476
Weight (lb.)	990	929, 384, 141

*Where three numbers appear, they are respectively for large spring, intermediate and inner.



RIGHT: *The next step is magnetic-particle inspection, where the surface of the spring is checked for flaws. Then the spring is given a stress-relieving treatment and is subsequently ready for the shotpeening operation. The effect of shotpeening is to impress a compressive stress pattern on the spring's surface, thereby giving additional protection against failure.*

After shotpeening, the spring is run through a bank of final inspections, matched against other springs to get an appropriate nest for each strut, and subsequently palleted for shipment.

Special Report: Navy R&D

(Continued from page 15)

marines — undoubtedly nuclear types, well before this decade is over—and being able to "kill" them.

Called "TENOC-61", this long-range Navy program was approved this past March by Admiral Arleigh A. Burke, former Chief of Naval Operations; and if carried out will multiply by many times the service's present research funding in oceanography.

The work expected to be done under the TENOC-61 program can be divided into eight areas:

1) *Military oceanography.* The bulk of the oceanographic money goes into programs directly supporting Navy development programs. Thus, $245 million earmarked "military oceanography" will pay for work in acoustics, magnetics and gravity, other physical properties of the sea, marine biology, Arctic operations and deep-sea phenomena. The Bureau of Ships, Bureau of Weapons, and ONR coordinate specific areas involving the efforts of about 20 Navy and civilian research organizations.

2) *Ships.* Ship-building and outfitting get $229 million. The TENOC program calls for constructing 35 new ships—16 survey vessels and 8 others to replace existing ships. This phase of TENOC is coordinated within the office of the Deputy Chief of Naval Operations (Development).

3) *Basic research.* Universities and private laboratories under contract with ONR will make studies in physical, chemical, geological, meteorological and biological oceanography. Budget is $210 million, third highest in the program.

4) *Oceanographic surveys.* Detailed mapping and charting of the oceans is needed for navigation, communications, detection and mine laying. During the decade, the Navy plans to spend $128 million for this work, which calls for a tenfold increase in basic data collection by fleet units. Coordinated by the Hydrographic Office, the information sought will include data on bathymetry, gravitational and magnetic fields, currents and sea temperatures.

5) *Instruments.* A $46-million program calls for improvements in all types of oceanographic instruments. Specific needs are for better sensors, cable and connectors, cable-handling winches, monitors and recorders, and telemetry equipment. The Hydrographic Office is responsible for coordinating this effort.

6) *Forecasting.* An $18-million program calls for achieving an operational marine-environment-prediction system by 1965. One phase of the program, coordinated by the Hydrographic Office, is the Antisubmarine Warfare Environmental Prediction Systems (ASWEPS). Oceanographic forecasts cover the prediction of sea ice, currents and other factors for optimum ship routing and for the conduct of surface, submarine amphibious, mine warfare and nuclear warfare operations.

7) Another $18-million program calls for expanding and improving oceanographic research and development facilities at 11 Navy and civilian installations.

8) *Information dissemination.* The National Oceanographic Data Center, dedicated a year ago, is a central depository and processing facility for oceanographic data (M/R, Nov. 28, p. 22).

During the next few years, the Center plans to introduce large-scale machine-processing techniques to oceanographic data-handling, and also expects to play a major role in the research and development of new instruments that will yield data compatible with the Center's function.

The Hydrographic Office will coordinate the information program, for which the Navy plans to spend $11 million under TENOC. Much more undoubtedly will be spent for such work because of the high interest of other government agencies.

The Navy's research installations are on their way to "first name" relationships with industry and with the service's highest policy makers. Secretary Wakelin maintains that this is the only way to keep up with technology and use it adequately for the national defense. It appears that industry will also benefit because it will be treated as a partner, instead of an adjunct, in the RDT&E effort. ⌗

Navy Research Problems

(Continued from page 18)

ited to passive (or otherwise secure) devices.

PROBLEMS (BuWeps): Develop a method for rapid determination of moisture in solid propellants.
BACKGROUND: Oven drying methods and chemical drying methods are laborious and time-consuming.

PROBLEM (BuShips): Develop a device (utilizing the Pilsch tube principle perhaps) to separate warm air from cold air. A similar device for water separation is also needed.
BACKGROUND: At the present time, closed loop cooling systems using air or water as the coolant are used to cool high-power electronic equipment aboard ship. Heat from these systems is discharged into the equipment compartment. A device similar to a Pilsch tube that could separate the coolant into hot and cold portions would be useful.

PROBLEM (BuWeps): Develop a nondestructive test method to measure bond strength between similar or dissimilar materials.
BACKGROUND: Present test methods are limited to ultrasonic and radiographic techniques. When used with solid-propellant rockets, the test results give only a relative index of the presence of a bond. They are of no use in determining the degree of the bond.

PROBLEM (BuShips): Develop an accurate method of taking simultaneous temperature measurements of sea water down to depths of 20,000 feet. These measurements must be taken in a vertical line from the surface at 10-foot increments down to 500 feet and at 20-foot increments below 500 feet. The vertical line must be maintainable in a 2-knot current.
BACKGROUND: Present temperature-measuring equipment does not make simultaneous measurements at all depths and does not measure temperature in a vertical line. The real need is a method to keep a line, chain, or array vertical when it is subjected to moderate currents during and after lowering from a stationary vessel.

SUPER-CAVITATING propellers developed through tests at David Taylor Model Basin are used on some experimental hydrofoils.

PROBLEM (BuWeps): Develop a rugged, portable, and extremely simple field-strength meter for high-level RF fields which will measure intensities from 0.01 to 1000 v/m with an accuracy of ±25% over the frequency range from 15,000 cycles to 15,000 megacycles.
BACKGROUND: The field-strength meters currently on the market do not satisfy this need. They are expensive, complicated, and limited in their frequency response. A simple, dependable instrument is needed; it may utilize any basic principle. Current technology should permit such a development, although the frequency range requirement will demand an ingenious solu-

tion, since it is coupled to practical use restrictions.

PROBLEM (BuWeps): Develop a temperature-measuring instrument for measuring rocket exhaust temperatures in the range of 5000°F.
BACKGROUND: In general, methods employing physical contact with the stream are unacceptable because of material limitations and the disturbances introduced into the stream. Methods employing remote sensors such as sound velocity meters and optical and total radiation pyrometers are particularly applicable if the effect of boundary regions can be minimized.

ELECTRONICS

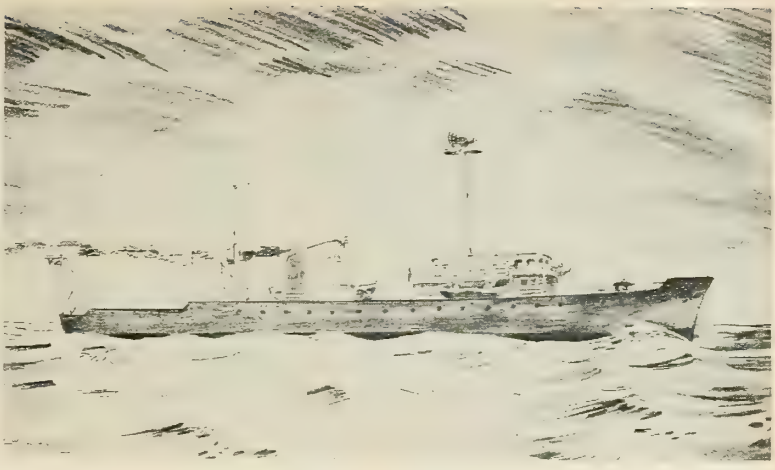
PROBLEM (BuWeps): Develop a rugged, multiple-channel recorder for use within test-fired torpedoes. The recorder should have 25 input channels and should furnish a permanent record in a form from which the data can be obtained quickly and processed automatically. The recorder should occupy less than 600 cubic inches.
BACKGROUND: As presently practiced, torpedo exercise and developmental unit runs require oscillographic monitoring of selected characteristics to permit reconstruction of actual performance after the torpedo is recovered. Since such programs are often sequential, the availability of data immediately after recovery would enable program modifications to be made quickly and both test programs and fleet exercises would benefit. At present the photographic processing requirement is a severe restriction which precludes more efficient programing.

PROBLEM (BuWeps): a) Devise a practical embodiment of cryogenic devices in a modular memory unit. b) Establish a practical, economical, mass-production technique for the basic cryogenic device. c) Find a substitute possessing the characteristics of the basic cryogenic device without its operating environment restriction (4° Kelvin).
BACKGROUND: Cryogenic units have demonstrated both theoretically and empirically that they possess a potential for significantly advancing the computer art. Unfortunately, their remarkable contribution is contingent upon operation in the super-conductivity regions of temperature, i.e., 4°K. This has necessitated the use of accessory equipment which effectively cancels much of the advantages offered by the devices. A further problem has maintained the devices as primarily laboratory curiosities: their manufacture is dependent on vacuum deposition processes which are poor in reproduction and consequently not susceptible to manufacture in quantity.

PROBLEM (BuWeps): Develop highly accurate digital output transducers. Development is needed in the area of transforming the variation of physical phenomena into a digital voltage with precision of one part in 2^8 to one part in 2^{10}; a frequency response from DC to several kc is needed.
BACKGROUND: At the present time, transducers with a digital output are not available. The analog output signal of present transducers must be converted to digital form by circuitry external to the transducer before it can be used as an input to digital computers.

The development might proceed along two lines: a) Examination of materials for characteristics suitable for application to the transforming of physical phenomena into a digital voltage; b) Refinement of analog instruments together with schemes of analog-to-digital conversion, perhaps in each end instrument.

PROBLEM (BuWeps): Design a feedback potentiometer for use in the high-temperature (1000°F) environments associated with missile servos.
BACKGROUND: Potentiometers used in missile servo systems tend to break down due to environmental heating. As the temperatures increase, the resistance of the bridge changes, and inaccurate servo positions result. Also, the solder used in the potentiometer sometimes melts and increased temperatures cause mechanical binding.



ARTIST'S DRAWING of the prototype of a family of oceanographic research vehicles currently being built for the Navy.

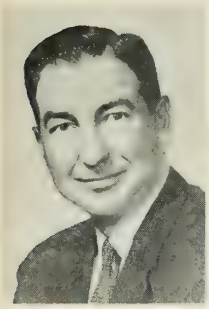
MISCELLANEOUS

PROBLEM (BuShips): Develop a dry storage battery with the following characteristics: a) Maximum diameter: 2.75 inches; b) Maximum length: 5 inches; c) Output: 250 watts at 12 volts for 18 minutes; d) Rise time: Approximately 5 seconds; e) Shelf life: 3 years; f) Activation: By injection of electrolyte upon impact.
BACKGROUND: The characteristics above constitute a needed improvement on an existing primary reserve battery used in a countermeasure beacon.

PROBLEM (BuWeps): An order of magnitude improvement in batteries is essential for their future utilization as primary power sources (torpedoes) and auxiliary power sources. Several improvements in specific types of batteries or in battery characteristics are needed: a) A battery that will provide 100 kilowatts for 15 minutes (torpedo propulsion)—500 watt-hours per pound or 19 watt-hours per cubic inch; b) A battery that will provide 10 kilowatts for 5 minutes (guided missile auxiliary power) — 200 watt-hours per pound or 7.5 watt-hours per cubic inch; c) A rugged dry cell capable of full capacity without activation after 10 years of shelf storage at temperatures to 120°F; d) A small, light battery that will operate reliably over a temperature range of –65°F to 160°F. It must be capable of automatic activation without warmup time; e) A reduction in cost, volume, and weight of all types of batteries, coupled with an increase in reliability of activation.
BACKGROUND: The field of underwater ordnance, with specific reference to mines and torpedoes, utilizes batteries as a basic energy source. The importance of developments in this field parallel the increased urgency of countering a growing submarine threat. Despite gains achieved through research and development, the situation in obtaining high-power, efficient, long-shelf-life batteries at a cost commensurate with their basic expendable nature is deplorable.

PROBLEM (BuDocks): Develop rapid means for stabilizing beach sands to support military operations.
BACKGROUND: The Bureau of Yards and Docks, over a period of years, has investigated various chemicals which can be added to beach sands in order to stabilize the sand so that heavy vehicular traffic can be supported. Chemicals studied were unsatisfactory because of their toxicity, the large logistic effort required in obtaining suitable mixing, placing and curing of the sands, and the inability of the stabilized sands to carry sustained traffic. A low cost, rapid method for stabilizing the sands which requires minimum equipment, is desired in order to increase the mobility of operating forces in a military operation.

PROBLEM (BuWeps): Develop a self-pressurization system for injection of propellants into liquid rocket engines.
BACKGROUND: The present method of introducing propellants into the thrust chamber of liquid rocket engines involves either the use of pressurizing grains or turbopumps. Both of these contribute weight and complexity to the operation of the engine. Yet, the propellants themselves afford a source of pressurization. ⌗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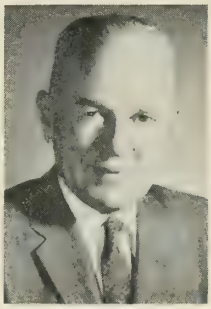
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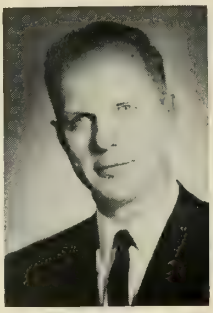

OSGOOD

CHACE

Barney N. Dagan and **Gerald E. Balsley:** Named vice presidents of Kaiser Steel Corporation. Dagan, as vice president of operations, will direct the company's steelmaking operations at Fontana, Calif. He was previously associated with Youngstown Sheet & Tube Co., and has been with Kaiser Steel since 1946. Prior to joining the Kaiser organization in 1950, Balsley worked for Schenley Industries and for Pacific Can Company.

R. E. Ousley: Named vice president-sales of Fleming Industries, Inc., Torrance, Calif. In the electronics and ordnance field for about 10 years, he was formerly vice president-sales for Networks Electronics.

Dr. Joseph A. Boyd: Director of the University of Michigan's Institute of Science & Technology, will join Radiation Incorporated, Melbourne, Fla., as vice president and assistant to the president. Dr. Boyd has been consultant for the Institute for Defense Analysis since 1956; consultant for the National Security Agency since 1957; special consultant to the Army Combat Surveillance Agency since 1958; and member, then chairman, of the Advisory Group on Electronic Warfare, Office of the Director of Defense Research and Engineering, since 1959.

Charles G. Gant, space systems operations executive at Ford Motor Company's Aeronutronic Division, Newport Beach, Calif., has been appointed general operations manager of Penetration Aids, formerly a component of Aeronutronic's Space Systems Operations but now on full operations status to implement the commitments of the secret decoy project being carried out for the Air Force ICBM program. Gant has had extensive government administrative experience and was formerly associated with the Lockheed Missile Systems Division research laboratories.

Col. Charles G. Patterson, U.S. Army (Ret.): Named a director and vice president in charge of planning by Belock Instrument Corporation's board of directors. He is a former director of special weapons in the Office of the Chief of Research and Development, and served as a member of the staff of the Army Ballistic Missile Agency and the Ordnance Missile Command. During World War II, Patterson was Air Defense Chief of the First Army.

F. E. Newbold, Jr.: Vice president and director of Fairchild Stratos Corp. and general manager of its Stratos Division, has been named corporate director, Washington operations, of the aerospace firm. All of the company's off-site representation activities will report to Newbold. He has been with Fairchild Engine and Airplane Corp. since 1940, starting as a student engineer, rising to vice president in 1952, and becoming a director in 1959.

Dr. Guenther von Elbe: Joined Atlantic Research Corporation as a staff scientist in the company's Kinetics & Combustion Division. Formerly with Combustion & Explosives Research, Inc. as vice president, Von Elbe has worked with the U.S. Bureau of Mines and with the Carnegie Institute of Technology.

Leonard Pincus: Vice president and director of the Microwave Laboratory of Quantatron, Inc., has been elected to the Board of Directors. Prior to his present position, Pincus was with Hughes Aircraft, Airtron, Inc. Division of Litton Industries, and Lockheed Missile and Space Division.

R. M. Osgood: Named general manager of a new, completely integrated eastern operation established by Sylvania Electronic Systems, a division of Sylvania Electric Products Inc. The operation was formed through consolidation of the division's Waltham Laboratories and Data Systems Operations in Needham, Mass. Osgood, who has been with the company since 1955, was formerly chief of the Electronic Defense Systems Division of the Air Force's Air Materiel Command.

Dr. Lloyd P. Smith: Research director, Research Laboratory, at Ford Motor Company's Aeronutronic Division, Newport Beach, Calif., has been appointed by the Office of the Secretary of Defense as a member of the Defense Science Board, and will also serve on the Executive Committee of the Board. Dr. Smith currently is chairman of the Physics Section, Research Division, American Ordnance Association, and a member of the Advisory Council, College of Engineering, Cornell University; Advisory Council, Department of Electrical Engineering, Princeton University; Solid State Physics Panel formerly connected with the Office of Naval Research; and Advisory Committee for Thermonuclear Research, Oak Ridge National Laboratory.

George S. Cushman: Promoted to the position of Vice President-Operations of the Lockheed Propulsion Company. He has recently been assigned assistant vice president-project management and contracts and assistant vice president-program management. Prior to joining Lockheed Propulsion Company, he was associated with Convair-Pomona and the Office of Guided Missiles for the Secretary of Defense.

Arthur F. Chace, Jr.: Formerly with Samson Cordage Works as executive vice president and director, has joined Vitramon, Inc., as executive vice president. He has been associated with Textron, Inc. and the Central Hanover Bank and Trust Co.

William S. Reid, Jr.: Promoted to *Minuteman* Contracts and Proposal manager for the Automatics Division, North American Aviation, Inc. In his new post Reid is responsible for the preparation, pricing and negotiation of all Autonetics *Minuteman* proposals and contract administration.

John J. Iffland: Acton Laboratories, Inc., a subsidiary of Bowmar Instrument Corporation, announced the election of Iffland to the post of president. He comes to the company from the Raytheon Company and had formerly been associated with the IT&T Laboratories, Harvard University Underwater Sound Laboratory, Pennsylvania State University Ordnance Research Laboratory, and the University of Michigan Aeronautic Research Center.

John J. Graham: Former vice president of Radio Corporation of America, has been named vice president and executive assistant to the president of International Telephone and Telegraph Corp. Before joining RCA he held executive positions with I.T.E. Circuit Breaker and the Budd Company.

contracts

AIR FORCE

$14,285,000—**Massachusetts Institute of Technology,** Cambridge, for research in reentry physics, acquisition of specialized equipment and for product improvement on spin-axis gyro bearings (two contracts).

$13,000,000—**Martin Marietta Corp.,** Denver, for activation of *Titan* operational sites in the vicinity of Lowry AFB, Colo.

$7,977,636—**General Dynamics Corp.,** San Diego, for technical information on the *Atlas F* missile and for installation and checkout of the *Atlas* missile (two contracts).

$5,600,000—**Lockheed Missiles and Space Co.,** Sunnyvale, Calif., for production of boosters for satellite vehicles and for design, fabrication and test of aerospace ground equipment for satellite vehicle launch support (two contracts).

$4,334,239—**Lockheed Aircraft Corp.,** Sunnyvale, Calif., for production of spare parts and ground support equipment for use in launch of satellite vehicles.

$4,000,000—**General Precision, Inc.,** Tarrytown, N.Y., and **AC Spark Plug Division, General Motors,** $2,000,000 each for research and development of a stellar inertial guidance system with application to long-range ballistic missiles.

$4,000,000—**Hughes Aircraft Co.,** Culver City, Calif., to provide automatic checkout equipment for inertial guidance packages for *Minuteman, Titan II* and *Skybolt* missiles.

$3,381,015—**North American Aviation Inc.,** for spare parts to support *Minuteman* guidance and control systems (work to be done at Downey, Calif.) and for production of launchers and aircraft modification kits for *Bullpup* (work to be done in Los Angeles).

$3,218,338—**Philco Corp.,** Palo Alto, Calif., for installation and checkout of a satellite vehicle tracking station.

$2,015,000—**Hughes Aircraft Co.,** Culver City, Calif., for *Falcon* missiles and related equipment.

$2,800,000—**Douglas Aircraft Co.,** Santa Monica, Calif. for launch services at Vandenberg AFB and for production of *Thor* space boosters (two contracts).

$2,600,000—**General Dynamics Corp.,** San Diego, Calif., supplemental contract for development of a high-impulse upper-stage vehicle.

$1,714,758—**The Ralph M. Parsons Co.,** Pasadena, Calif., supplemental contract for development of a *Titan II* subsystems training program.

$1,700,000 — **Aerojet-General Corp.,** Sacramento, Calif., for research and development of the *Titan* weapon system.

$1,272,754—**North American Aviation, Inc.,** for production of spares in support of the *Hound Dog* missile.

$1,000,000—**Alpha Corp.,** Richardson, Tex., for hardened antennas for the ballistic missile command and control nets at *Atlas* and *Titan* sites.

$1,000,000—**Lockheed Aircraft Corp.,** Sunnyvale, Calif., for equipment and support of launch vehicles.

ARMY

$2,308,630—**Raytheon Co.,** Andover, Mass., for parts, components and materials to support the NATO *Hawk* missile program.

$1,818,572 — **Hayes Corporation,** Birmingham, Ala., for work on training equipment to be used in connection with the *Pershing* missile system.

$1,000,000 — **Belock Instrument Corp.,** for continued engineering and production of training simulators for use in conjunction with the *Hawk* missile program.

$973,114—**Sperry Rand Corp., Sperry Utah Division,** Salt Lake City, for engineering services for *Sergeant* guided missile system.

MISCELLANEOUS

$40,000,000—**Collins Radio Company,** Dallas, from **North American Aviation, Inc.,** for the communications system for the *Apollo* project.

$2,000,000—**Douglas Aircraft Co., Inc.,** Santa Monica, Calif., from **Lockheed Missiles and Space Co.** and the **Radio Corporation of America** for shrouds and spin tables for *Agena B* payloads.

$1,400,000 — **Moog Servocontrols, Inc.,** East Aurora, N.Y., from **Martin Marietta Corp.,** Denver division, for servoactuators for the *Titan II* missile.

$1,093,995—**General Precision's Kearfott division,** Little Falls, N.J., from **General Dynamics,** San Diego, for additional production quantities of precision gyros for use in the *Atlas* missile.

$980,000 — **Espey Manufacturing and Electronics Corp.,** New York, N.Y., from **Martin Marietta Corp.,** for battery charger power supply units for the *Titan II.*

$800,000—**United ElectroDynamics Co.,** Salem, Mass., from **General Dynamics/Astronautics,** for establishment and operation of chemical laboratories at *Atlas* missile sites.

$600,000 — **Ling-Temco-Vought, Inc., Temco Electronics and Missiles Co.,** from **North American Aviation,** for a program to assure reliability for actuators used in the *Minuteman.*

$534,000—**American Electronics, Inc., Instrument division,** add-on contract from **General Dynamics/Pomona,** for *Terrier* and *Tartar* components.

$500,000 — **North American Aviation,** from **Sperry Gyroscope Co.,** for 150-ft.-diameter radome.

NAVY

$4,800,000—**Western Electric Co.,** New York City, for fire control equipment.

$4,000,000—**Minneapolis-Honeywell Regulator Co., Aeronautical Division,** St. Petersburg, Fla., for manufacture of reference and pendulous gyroscopes for *Polaris* missile guidance systems.

$2,954,367—**Sperry Rand Corp., Sperry Gyroscope Division,** Syosset, N.Y., for development of ship's inertial guidance system including a display and maintenance console for *Polaris* submarines.

$1,881,600—**West Bend Co.,** West Bend, Wis., for launcher for *Zuni* rockets.

$1,587,500—**Merz-Chambers Corp.,** Shelbyville, Ind., for launchers for *Zuni* missiles.

$1,480,516 — **Radiant Manufacturing Corp.,** Morton Grove, Ill., for Aero 6A-2 rocket launchers for aircraft rockets.

$1,400,000—**United Aircraft Corp., Norden Division,** Norwalk, Conn., for gas-pressure systems for the advanced *Terrier* and *Tartar* missiles.

$1,358,903—**Vitro Corp. of America,** Silver Spring, Md., for design engineering services in connection with *Terrier, Tartar, Talos* and *Typhon* missiles.

$1,250,000—**General Instrument Corporation,** for production of electronic fuzes (work to be done at the F. W. Sickles Division, Chicopee, Mass.).

$900,000—**Collins Radio Co.,** Dallas, for two command control destruct systems for the Pacific Missile Range.

Scientist/Engineer Shortage

(Continued from page 12)

more attractive to the creative minds.

Another remedy is to encourage more women into engineering. Red China and Russia have of course demonstrated the success of this idea.

The only other source is persons without degrees. The National Science Foundation estimates that in the years from 1950-59 about 23% or 78,000 engineers without sheepskins entered engineering work. NSF goes on to say that if the proportion of engineering freshmen does not increase, retention rates improve, and transfers into engineering schools rise, the deficit must be made up of untrained personnel.

NASA tries to meet some of its problems by hiring people with degrees in a number of different disciplines, and molding them into "aerospace scientists." According to NASA's Dr. Allen Gamble, it is the only organization which classifies its people strictly on the function of their work, and not upon the academic degrees they hold.

As an example, its data systems category contains these degrees: 5 M.E.'s, 3 A.E.'s, 51 Math, 12 Physics, 41 EE, 1 Civil E., 1 Meteorology, 1 Economics, 1 Soc. Stud., 3 Education, and 1 English.

• **NASA's courting song**—The big problem of government agencies is the tremendous disparity of income between their top people and those in comparable positions in industry. (See chart). At the BS level, NASA already is $1000 behind. At higher levels, it can only offer half the salary industry can offer.

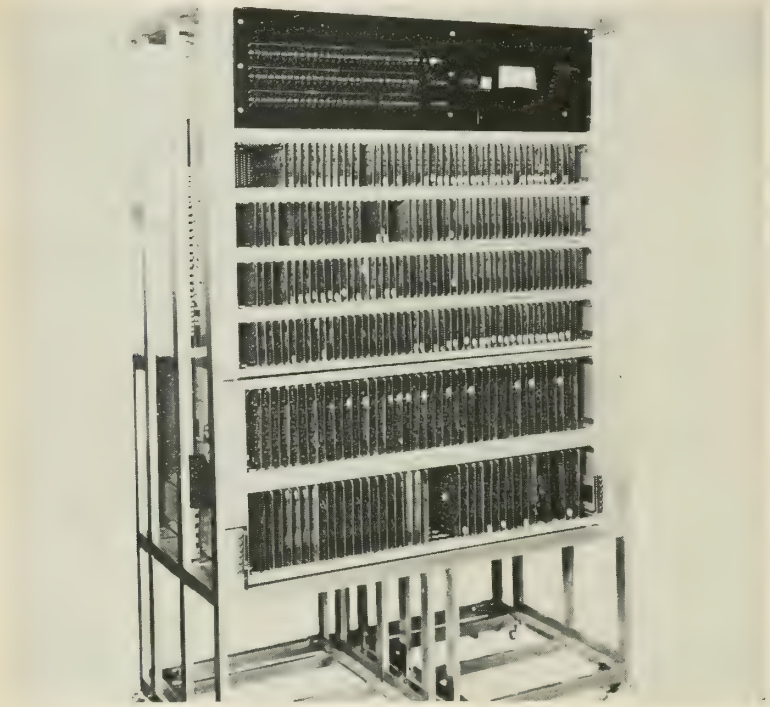
NASA attempts to counter this by the attractiveness of its mission and its work. And many young scientists and engineers join NASA just for the experience of working with some of the research leaders already there.

Since NASA has none of the proprietary restrictions associated with the production of a product, NASA scientists get a chance to publish their work sooner and thus receive professional recognition.

NASA supports the advanced education of many of its people. They get degrees paid for by NASA, on the agency's time.

But money is still an attraction. Lacklan notes that more professional people drop out when their children are entering college than at any other time.

On the Administration's boards there is a recommendation to Congress that it raise the pay of senior scientists next year to a top of from $25,000 to $30,000 a year. If this and other measures are not taken soon, NASA's expansion hopes look dubious. ⌘



New Product of the Week: 1.5 Microsecond Core Memory

A FERRITE CORE MEMORY with a 1.5-microsecond cycle time is available from the Computer Products Division of Ampex Corp.

Compatible with all current computer logics, the large-capacity, random-access LQ can be used for data processing, communications, transportation and other tasks where high computer speed and capacity are required. The LQ core memory has a rate of 667 Kc (1.5 ms) for a complete read-restore or write-clear cycle. Special subminiature ferrite cores, high-speed gating circuitry and linear-select, partial flux techniques helped achieve this speed in a standard production unit.

Storing binary information, the 2048, 4096 and 8192 memory modules use a linear word select) drive system and operate in three modes: read-restore, clear-write, and split read and write. Word lengths are up to 56 bits. Operations may be conducted on full words or on partial words. Larger capacity memories may be obtained by using combinations of standard memory modules.

All logic and voltage regulation circuits are on printed plug-in cards for ease of maintenance. Controls for starting, stopping and resetting the memory may be installed at the computer.

Circle No. 225 on Subscriber Service Card

Symbol Generator

A unique symbol generator for cathode-ray tube displays and two complementary units, a line generator and a format generator, are being marketed by the Strand Engineering Co., a division of Datronics Engineers, Inc.

Available in two models, the Symbol Generator is highly flexible and provides reliability, readability and speed at moderate cost. The generator and its complementary units will form the core of the Datronics display products line which will be expanded to include a complete line of modular building blocks for display systems.

Circle No. 226 on Subscriber Service Card

Heavy Packaging System

Zero Manufacturing Co. is marketing a system for pallet- and shroud-packaging heavy, fragile components such as rocket engines, Klystron tubes, missiles and other equipment. The system mates a lightweight aluminum modular container to a steel or aluminum pallet that is easy to handle, has necessary shock mounting and permits complete access to the component.

The bottomless modular container has a Zero male closure, while mounted on the pallet is a gasketed environmental Zero female closure; the shroud simple fit to the pallet by this method and is securely latched. The system can be re-used many times. The pallet can also be converted for use as an in-plant dolly.

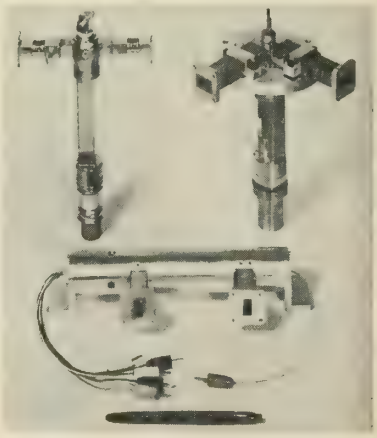
Circle No. 227 on Subscriber Service Card

Traveling-Wave Tubes

Traveling-wave tubes operational with power outputs up to 1 kilowatt in Kμ band are in production at General Electric Co.

Two of the three tubes provide more power output across their 14,000-18,000 megacycle frequency range than any other TWT's now commercially available.

The highest-powered, the Z-5184, has a peak saturated power output of more than 1 kilowatt. The other two,



both for continuous-wave operation, are the Z-5183, with a CW output of 10 watts; and the Z-5182, with a minimum CW output of 150 milliwatts.

The tubes can be used individually or in tandem sequence.

Circle No. 228 on Subscriber Service Card

Intensified Plasma Heat

A new plasma flame torch increases by more than ten times the potential heating capacity of such torches, and places under push-button control a heat source of a magnitude previously unattainable by any practical means.

In the unit, produced by Thermal Dynamics Corp., an innovation in com-

ponent configuration permits the combining of laminar gas flow with the transferring of the arc from torch to workpiece or to a cooled anode outside the torch. Operating at 90% efficiency, the torch produces contamination-free plasma and a quiet, non-oscillating flame with an ultra-high heat transfer rate. Continuous operation is possible with argon, nitrogen, helium, hydrogen, or any combination of these gases, with heat input ranging from 130,000 to 600,000 Btu/lb. of plasma gas. Temperatures in these ranges are well in excess of 60,000°F, and the flame can be varied in length from 1 to 20 in.

Circle No. 229 on Subscriber Service Card

AFC Systems

Orion Electronic Corporation is marketing AFC units for frequency control applications. It employs only high-temperature components, such as silicon transistors and tantalytic capacitors, to insure high temperature operation of 125°C. This particular AFC unit is designed to keep the difference signal between the two oscillators within a prescribed error for wide variations in their characteristics.

Orion Series C units are being made available in three distinct types: miniature tubes, subminiature tubes or transistors. Since each AFC unit must, of necessity, be designed for a specific application, the manufacturer suggests that system details be furnished for an engineering analysis to determine requirements for the AFC units.

Circle No. 230 on Subscriber Service Card

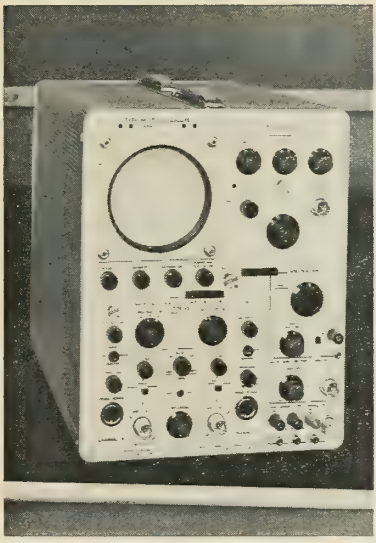
Ferrite Bead Chokes

National Radio Co. is marketing a Ferrite Bead Choke for use in high-frequency and very-high-frequency ranges. At power supply and audio frequencies. the choke presents no more impedance to these circuits than an ordinary hookup lead. At frequencies in the range above 10 mc., the unit exhibits a substantially constant a-c resistance and impedance, making it extremely useful for isolating high-frequency signals from the power supply and audio frequency circuits.

Circle No. 231 on Subscriber Service Card

Dual-Trace Oscilloscope

A complete pulse-sampling system with risetime of 0.35 nonosecond, the Type 661 Oscilloscope is available from Tektronix, Inc. Characteristics include capabilities for triggering externally or internally on either A or B trace, for observing equivalent sweep times from picoseconds to a millisecond, for displaying repetitive signals from fractions of a millivolt to volts and for measuring risetimes from hundred of picoseconds



to a millisecond—with uniform, high writing rate at all sweep speeds over the full 8 cm by 10 cm display area. The Type 661 also features the ability to show Lissajous patterns on the 5-inch crt, in addition to single and dual-trace displays and signals added algebraically.

Circle No. 232 on Subscriber Service Card

Gimbal Bearings

Precision gimbal bearings have been developed for missile guidance systems gyroscopes by Industrial Tectonics, Inc. Two such bearings in a common housing are capable of maintaining the axis of gyro rotation within two arc seconds of angularity. Under 330-lb. axial load, maximum breakaway torque is held to 12 oz.-in. or less. This extremely low torque permits miniaturization of driving motor. Torque is also held constant to prevent errors in the guidance system.

Circle No. 233 on Subscriber Service Card

Thermostatless Crystal Oven

Marconi Instruments is marketing a crystal oven, Type F3006, using a new stabilizing principle which eliminates the temperature fluctuations inevitably arising from thermostatic control. The

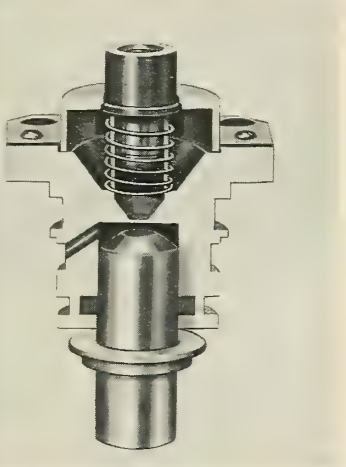
unit stabilizes at 79.5°C; further types to be available will stabilize down to 48°C. Cyclic temperature variation is claimed to be less than ±.0014°C, giving an improvement of 100:1 or better.

The crystal chamber is ¾ in. diameter by 2 in. long and can accommodate transistors or other small devices as well as crystals. External dimensions are 2½ in. diameter by 6⅝ in. and connections are via an octal tube base.

Circle No. 234 on Subscriber Service Card

Pressure Indicators

Unique pressure and differential pressure indicators for a wide range of industrial and airborne applications are being produced by Pall Corp. The units, available in extremely small sizes, are part of the Deltadyne line of measurement and control devices. They operate



on a magnetic principle which eliminates the need for mechanical linkages. Deltadyne indicators are available for system working pressures up to 10,000 psi, operating temperatures from −65°F to 275°F and actuation from 1.5 to 100 psid. Extended ranges can be supplied on special order.

Circle No. 235 on Subscriber Service Card

High-Vacuum Thermocouple Controller

Vacuum-Electronics Corp., has available a high-vacuum thermocouple controller. Designated the TC-9, it is a dual control unit for the automatic control of vacuum systems. The TC-9 is an automatic solid-state device with continuous "no kick" indication even in the control region. It is designed for system protection, automatic process control, pressure monitoring, and for remote operation in inaccessible areas. Control action is accomplished without contacts and is a positive nonlocking action eliminating chatter and contact

replacement. Dual control points are provided for high- or low-pressure actuation. They are set by adjustable pointers indicating exact point of control.

Circle No. 236 on Subscriber Service Card

Gamma Analyzer

Model GSS-1B, a gamma analyzer that operates automatically without adjustment to scan, record and analyze emitters having energies varying from Nuclear Measurements Corp. An equal

0.003 kev to 3 mev, is available from percentage of each peak is automatically analyzed, and absolute peak comparisons are made directly, regardless of energy differences. Readout is provided in three forms—count for preset time period, continuous counting rate, and graphic recording. Energies are recorded on a graph calibrated in mev.

Circle No. 237 on Subscriber Service Card

Compression Amplifier

A linear amplifier with automatic stepped gain control is available from Gulton Industries' Ortholog Division. The Ortholog Compression Amplifier, Model OR-LA/1 has a wide-band response of from 30 to 20,000 cps and low distortion. Input signals of up to 100 db dynamic range can be compressed to 20 db. Variable gain is provided in discrete 10 db increments. Output gain is continuously adjustable from 0 to 50 db, for a maximum output voltage range of 1 to 10 volts.

Circle No. 238 on Subscriber Service Card

Analog Mag-Tape System

An analog magnetic tape system having an all-solid-state FM section of increased capability is being marketed by Minneapolis-Honeywell's Industrial Systems division. The system, called the LAR7400, is designed for data handling in connection with telemetry, jet and rocket engine tests, environmental vibration, wind tunnel analysis and other applications.

The system records 20 KC FM data at 40% carrier frequency deviation with 40 KC optional at 20% deviation. When arranged for direct record, the LAR 7400 accepts either 100 KC at 60 ips in standard or 30 ips in extended mode.

Circle No. 239 on Subsciber Service Card

Sweep/Signal Generator

A sweep/signal generator providing 8 discreet, adjustable outputs is available from Telonic Industries, Inc. Designated Telonic Model No. SP-135, the generator was developed for use in production applications to supply swept signals to multiple calibration stations using only a single instrument.

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new literature

VOLTAGE REGULATOR—A catalog describing the Regohm voltage regulator is available from Electric Regulator Corp. Information includes accuracy of regulation—within 2% for the combined effects of line load, frequency and power factor variation; insensitivity to frequency—54-66 cps model holds output to 0.5%, 45-1000 cps model holds output to better than 2%. The units will regulate either a-c or d-c output voltages.

Circle No. 200 on Subscriber Service Card

TRANSISTOR MANUAL — ARINC Research Corp., subsidiary of Aeronautical Radio Inc., has published Volume II of its Transistor Specification Manual. In Volume I of this work, issued in 1960, the company brought together for the first time all of the latest specifications for transistors on the Military Preferred List (MIL-STD-701A) and the ARINC Semiconductor Device Preferred List (ARINC Spec. No. 2,409). Included in the 87 specifications covered were several for European transistor types. Volume II complements rather than replaces Volume I. It contains 19 newly-developed military specifications, and revised specifications for 19 of those previously published. It features a section on Application Notes for MIL-STD-701B transistor types, designed to help the engineer select the most appropriate device for his specific use. This information, ARINC Research says, is not found in manufacturers' commercial data sheets or in the military specifications. Volumes I and II are available in matching looseleaf binders at $10 and $8 per copy, respectively.

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PLASTIC MOLDING—Reinforced plastics production methods are described in a 16-page booklet entitled "Guide and data for Engineers and Purchasing Agents," just published by the Reinforced Plastics Division of The Society of the Plastics Industry, Inc. Six basic molding procedures are discussed, together with advantages and applications of each, and tabulations present physical and chemical properties of parts produced by the different techniques.

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REINFORCED PLASTIC — General properties and thermal properties for Tayloron PA, a high-temperature asbestos-base reinforced plastic developed for rocket applications, are given in Bulletin 8.5 published by Taylor Fibre Co. Sizes are given for the various forms in which Tayloron PA is supplied. These forms include laminated sheet, molded rod, molded tube, rolled tube, molded shapes and molding forms.

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COOLING/RETENTION—A Catalog 1-W, describing more than 10,000 electronic cooling and/or retention device is available from The Birtcher Corp. Contents include descriptions and technical data on tube clamps for retaining tubes and electronic components, tube top-holding retainers for various sizes of vacuum tubes, clamps for miniature plug-in tubes and components, JAN shield inserts for tubes, transistor retaining clips, and transistor/component heat radiators.

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THERMOCOUPLE SELECTOR BOARD—A sample board for quick and easy selection of thermocouples is offered by Smith Thermotronics, Inc. The "Big Four" thermocouples shown will satisfy over 90% of the standard thermocouple applications, enabling the user to select a thermocouple from stock which is custom pre-engineered to suit many uses. All complex ordering instructions are eliminated.

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JANUARY

Automotive Engineering Congress and Exposition, sponsored by Automotive Engineers, Inc., Cobo Hall, Detroit, Jan. 8-12.

8th Annual Symposium on Reliability and Quality Control, Statler-Hilton Hotel, Washington, D.C., Jan. 9-11.

1962 Business Outlook Conference, sponsored by the Los Angeles Chamber of Commerce, Biltmore Hotel, Jan. 10.

30th Annual Meeting, Institute of the Aerospace Sciences, Hotel Astor, New York City, Jan. 22-24.

National Plant Engineering and Maintenance Show and Conference, Convention Hall, Philadelphia, Jan. 22-25.

Solid Propellant Rocket Conference, ARS, Baylor University, Waco, Tex., Jan. 24-26.

American Society of Mechanical Engineers, 2nd Symposium on Thermo-Physical Properties, Princeton, N.J., Jan. 24-26.

FEBRUARY

Western Electronic Week and Pacific Electronic Trade Show, Palm Springs, and Los Angeles, Feb. 3-11.

Winter Convention on Military Electronics, IRE, Ambassador Hotel, Los Angeles, Feb. 7-9.

International Solid State Circuits Conference, Philadelphia, Feb. 14-16.

Tracking and Command of Aerospace Vehicles, Institute of the Aerospace Sciences, San Francisco, Feb. 19-21.

30th Annual Symposium on Nondestructive Testing of Aircraft and Missile Components (Southwest Research Institute), Gunter Hotel, San Antonio, Tex., Feb. 27-Mar. 1.

MARCH

Institute of Radio Engineers, 8th Scintillation and Semiconductor Counter Symposium, Washington, D.C., Mar. 1-3.

Armed Forces Communications and Electronics Association, Cape Canaveral Chapter, Symposium, Cocoa Beach, Fla., Mar. 6-8.

Flight Propulsion Meeting (classified), Institute of the Aerospace Sciences, Cleveland, Mar. 8-9.

1962 Symposium on Packaging of Chemical Products, sponsored by Manufacturing Chemists' Association, Inc., St. Louis, Mar. 13-14.

Goddard National Space Conference, sponsored by the National Rocket Club, Sheraton Park Hotel, Washington, D.C., Mar. 14-16. (Goddard Memorial Dinner on Mar. 16.)

Electric Propulsion Conference, sponsored by American Rocket Society, Hotel Claremont, Berkeley, Calif., Mar. 14-16.

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The Spartan Approach to Space

LATE IN DECEMBER, the Soviet Embassy here in Washington invited a small group to view an hour-long film on Maj. Titov's historic 17-orbit flight around the earth. The film report previously had been seen abroad but this was its first showing in the United States.

The motion picture was remarkable both for what it did reveal about the Russian space program and for what it did not. It traced Titov's trip from his early training through his orbital flight to the reception accorded him in Moscow on his return.

The film brought immediately to attention the fact that the Russian space effort apparently is being conducted on the same spartan standard of living which applies to the entire Soviet economy. Tape recorders for monitoring in-flight radio conversation were simple portable table models. Equipment was sparse by contrast with U.S. standards and was casually placed in rooms with wooden floors and heavy drapes—the type of public room quite common in the Soviet Union.

Although computers were in evidence, Soviet technicians were shown plotting the position for retro-firing by hand with the aid of a ruler. Medical facilities for the astronauts were not elaborate. The bus used to transport Titov to the launch pad seemed to have been modified only slightly from a standard Russian bus. It certainly was a contrast to NASA's shiny van.

Only in one place were the Russians shown to have something comparable to ground equipment of the U.S. space program—in their central control room, which possessed a global map display and other equipment similar to Project *Mercury* control at Cape Canaveral.

We do not point this out derisively. The reaction is, instead, one of keen interest in what the Soviets have accomplished with equipment which is, by our sophisticated standards, quite crude.

There is indeed a lesson in it for us. The Russians, accustomed to a more severe way of life, carry this over into their space programs. As Americans, we are inclined to demand "the very best." The fact is that "the very best" is not always necessary and frequently takes longer to produce. We could sometimes save both time and money by settling for something less than perfection in areas where performance and safety are not affected.

Another interesting feature of the film was the size of the Russian group of astronauts. Perhaps a dozen were shown throughout the film and at least eight were shown together in one of the training sequences. It was noteworthy that the backup astronaut for Titov's flight was completely suited up and rode in the bus with him to the launch pad. If Titov had broken his ankle getting off the bus, there would have been no delay. His backup was right there and ready to go.

As expected, little was seen of the takeoff. A shot from high on the gantry showed the astronaut approaching the base of the gantry but the missile itself was not in view. Rails on the pad indicated a roll-back gantry. This high shot was followed by a close-up of the Russian astronaut entering the elevator. The footage which then showed the elevator rising to the top of the gantry appeared to be taken of a model, again with no missile visible.

The launch itself was presented largely as a cloud of orange-tinted dust, with a split-second glimpse of a *Thor*-like nose rising out of the cloud.

The sequence of the model elevator and the launch was the only blatant bit of fakery apparent in the film, although we must say that if the Russians were getting the quality of television reception from the space craft the film demonstrated, then our TV industry still has a lot to learn.

A model of the *Vostok II* spacecraft was employed to show its position in orbit. Its shape confirmed the sketch which appeared in this magazine on December 18, page 14.

Views of Titov inside the spacious capsule during the flight indicated that he enjoyed at least part of his journey. No sequences were shown of his seasick periods. At one point, he was shown taking nourishment from a tube. The roominess of the *Vostok II* is impressive in comparison with the *Mercury* capsules. Flight equipment matched that previously revealed by the Russians.

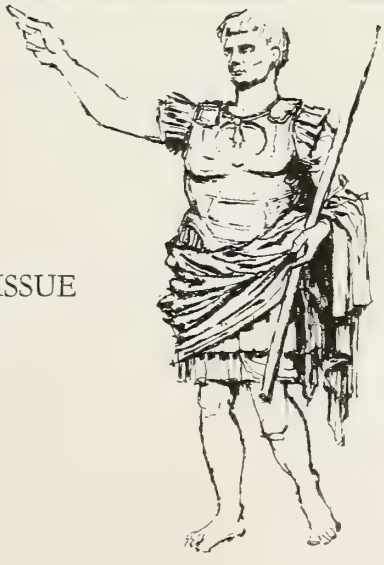
NO DETAILS of the landing were shown, other than confirmation that Titov did land by parachute. This sequence opened with the astronaut already on the ground and pulling in his orange and white chute. Earlier portions of the film, devoted to training, had displayed a water drop and survival test similar to those carried out for Project *Mercury*. Tests of an ejection escape system also were shown.

There is, of course, no way to tell how much of the film was made at the time the events shown were occurring and how much was taken later. We suspect that some of the scenes of Titov's training were re-staged after the successful flight, but certainly one cannot fault that as a legitimate dramatic device.

All in all, we found the film fascinating. The version we saw had a Russian soundtrack, but the embassy provided a running translation. We wish everyone in the industry could see it.

There is no spur quite as effective as a demonstration of how well the opposition is doing.

William J. Coughlin



a rare bird indeed . . .

MISSILES AND ROCKETS
SECOND ANNUAL
RESEARCH AND ENGINEERING ISSUE

theme: MILITARY SPACE SYSTEMS

publishing date: March 26, 1962
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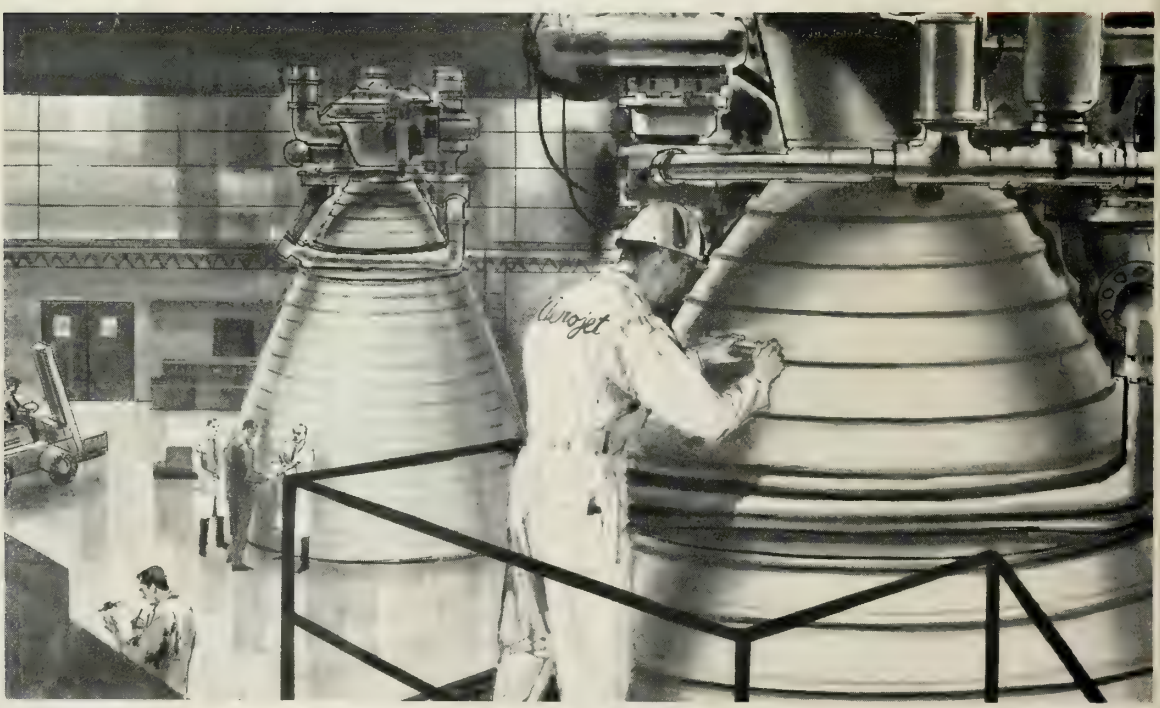

Engineers, scientists—investigate outstanding opportunities at Aerojet

JANUARY 8, 1962

missiles and rockets

THE MISSILE/SPACE WEEKLY

JAN 1962
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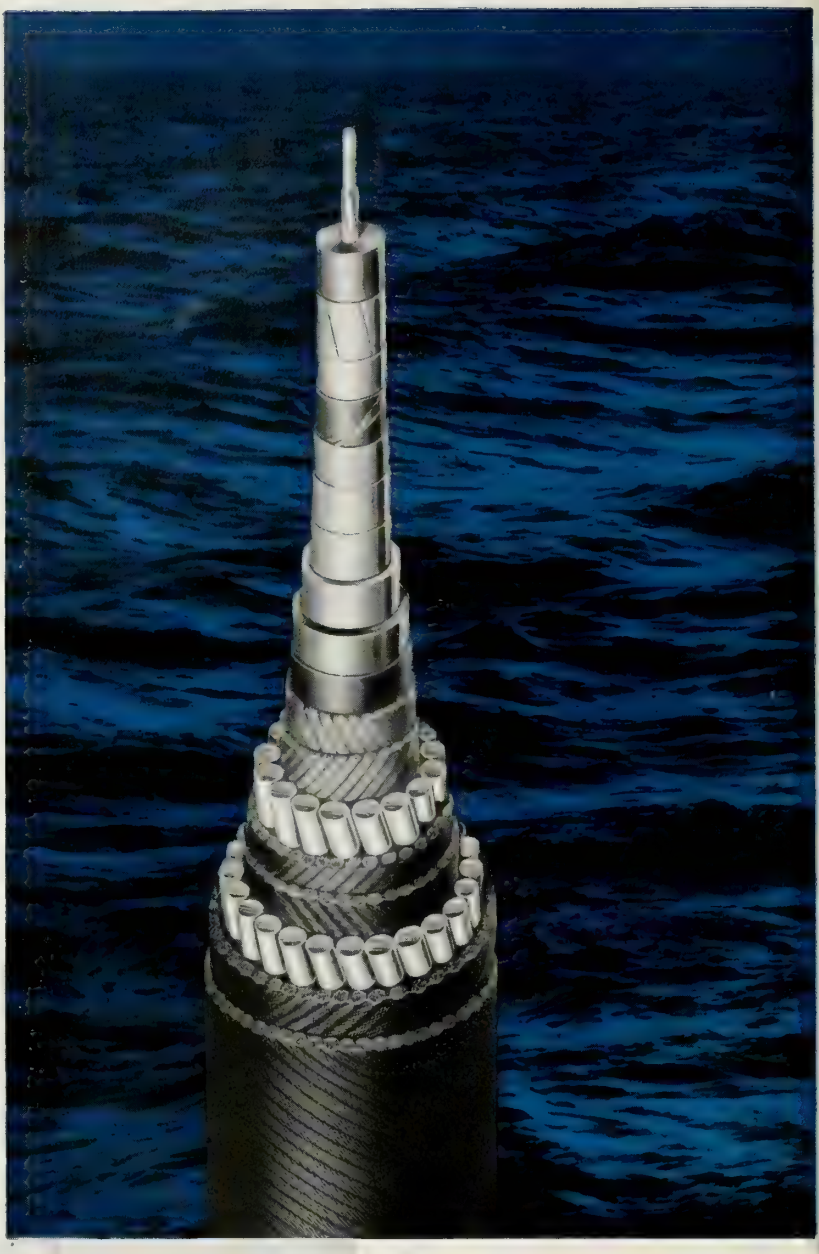
Space Council Unifying U.S. Program Objectives

- **Nova Awards Due By Mid-Year**
- **New Apollo, Gemini Designs**
- **Beryllium Breakthrough**

New Army Space Tracker

AN AMERICAN AVIATION PUBLICATION

Submarine Cables for Communications, Control & Power



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The Calibre of An Aerospace Organization is Evidenced by the Calibre of the Problems Put To It by its Customers — and by the Company to its Engineers

Engineers, Scientists

what's your opinion:

1

ON HOW TO CREATE A REALISTIC SPACE SIMULATOR?

This is a question put to Bell Aerosystems last year by the Air Force. If you had been a member of Bell's technical staff then, you might have been one of those who developed the space environment simulation concept now being engineered into actuality here. It is based upon a high-resolution, closed-loop television system superimposing images generated by 3 studios. Many stimulating problems, however, remain to be solved in: development of an electronic planetarium, real time digital flight dynamics, television image insetting techniques, TV noise alleviation techniques.

2

ON HOW TO PROVIDE OPTIMUM VEHICLE TOUCHDOWN DISPERSIONS WITH A FULLY AUTOMATIC, ALL-WEATHER LANDING SYSTEM?

Your informed opinions on any aspect regarding landing of boosters or space vehicles will receive thorough consideration. Bell engineers have already created a system in landing conventional aircraft providing a 30% improvement in this area, as demonstrated by 4000 landing tests made by U.S. Navy and Air Force planes. Vehicle landing systems and specialized equipments are advanced concepts now under study.

3

ON HOW TO PROVIDE AN ASTRONAUT WITH POSITIVE, FLEXIBLE STEERING CONTROL IN SPACE?

Your answer will certainly contain the statement that much depends upon the particular space mission but that reaction controls will be the foundation of the system.

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The three problems high-lighted above are representative of the wide range of unusual challenges offered engineers at Bell. Others concern such diverse projects as advanced Agena* rocket engines for NASA's Ranger and Marine vehicles; Hydroskimmer (air cushion) amphibians for the U.S. Navy; battlefield surveillance systems; automatic checkout equipment; missile & drone recovery systems. Another important field at Bell is Inertial Guidance and Navigation Systems, many of which employ an appropriate member of Bell's family of Hipernas** inertial platforms. *If you would like to pit your talents against tough-calibre problems, look into current openings with Bell.*

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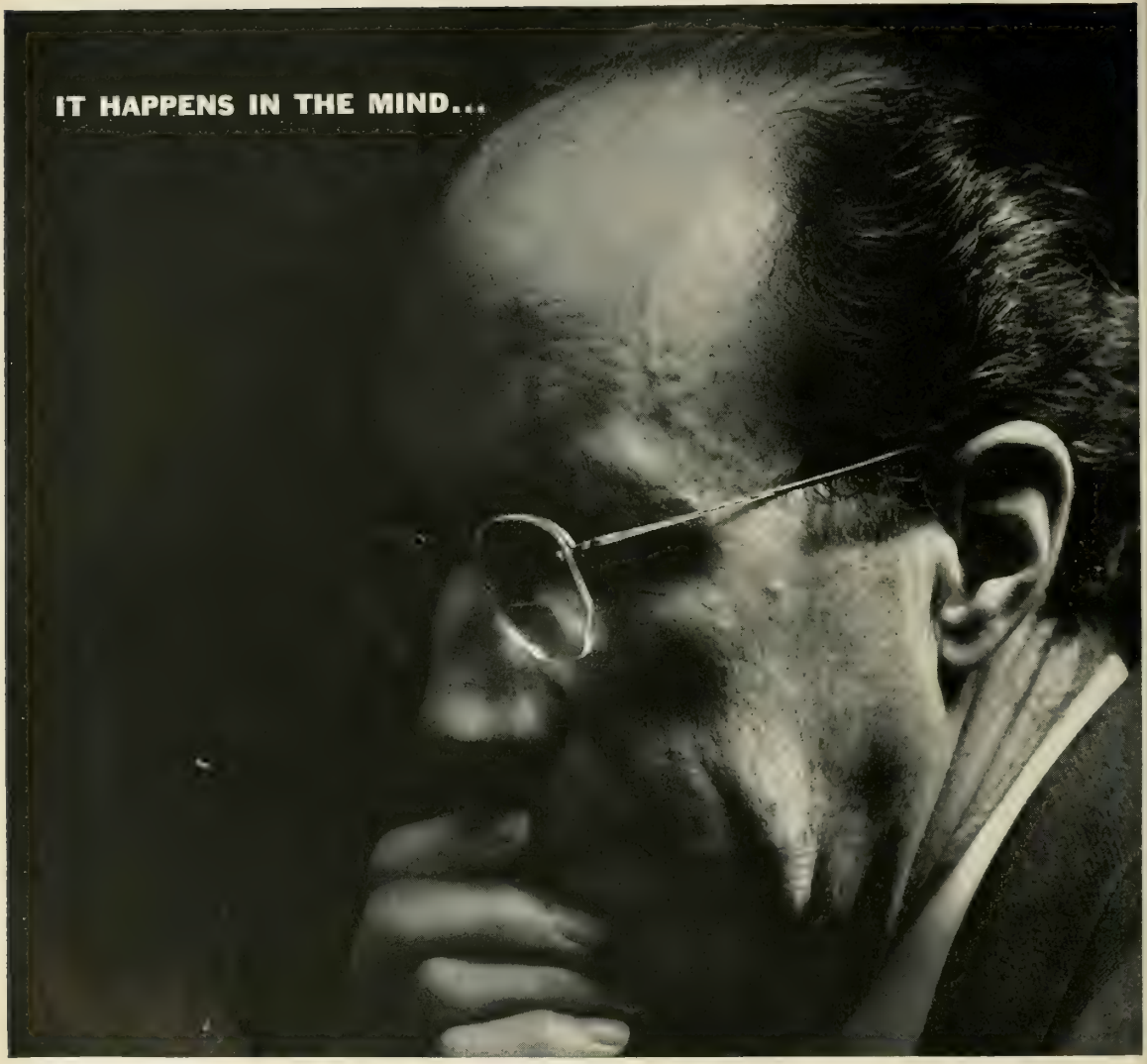

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For each creative task, Bell Laboratories utilizes whatever serves best—mathematical analysis, laboratory experimentation, simulation with electronic computers. Together they constantly advance communications and weapons systems for the Armed Services.

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THE MISSILE / SPACE WEEKLY

missiles and rockets

Volume 10, Number 2 January 8, 1962

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THE COVER

Army's new Precision Instrument Mount (PIM), an electro-optical system giving unprecedented space-tracking accuracy, was developed by AMF and Signal Corps. See p. 10.

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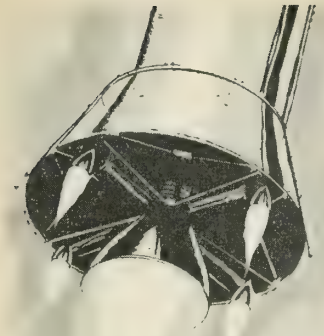

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letters

First NASA Issue

To the Editor:

You and your people did a tremendous job on the special NASA issue.

O. B. Lloyd, Jr.
Director
Office of Public Information
National Aeronautics
and Space Administration
Washington

To the Editor:

I just finished reading your First Annual NASA issue and found it to be truly a "first" in coverage of America's new frontier and the approaches to conquer it. I was particularly pleased to read of the people and organizations who will be playing such a vital role in our future. Too often the individuals are overlooked.

In your article on *Apollo*, you briefly describe two management control techniques, PERT and PDP. I would be very grateful if you could assist me in obtaining further information on these techniques.

M. F. Brown
Olin Mathieson Chemical Corp.
East Alton, Ill.

The computerized PERT (Program Evaluation and Review Technique), first developed by the Navy for Polaris, is described in M/R, July 17, 1961 (p. 110) and in the July, 1961, issue of ARMED FORCES MANAGEMENT, *an American Aviation Publication. PDP (Project Development Plan) is a system devised by NASA for its own programs; although it involves data processing to a degree, it is not comparable to PERT in this respect. NASA can supply further information on PDP. —Ed.*

To the Editor:

We would like to compliment your NASA Editor, Hal Taylor, and his task force on the splendid NASA report.

C. W. Murphy
Hughes Aircraft Co.
Culver City, Calif.

To the Editor:

I want to congratulate you on the fine coverage you provided on the wide and diverse areas of the National Aeronautics and Space Administration. In the particular area of Tracking and Data Systems, the presentation was very fine, although there were a few minor items that I believe should be clarified in the interest of credit to our cooperating agencies and countries:

a. Goddard is responsible for the technical management and operation of the entire *Mercury* net. The Langley Research Center directed the establishment of the network. After completion of the network, the technical and operational management responsibility was transferred to Goddard earlier this year, along with a large percentage of the key personnel from Langley, who are now integrated in the Goddard Manned Space Flight Support Division as a truly Goddard team.

b. Goddard is responsible for the specific manning and operation of five of the *Mercury* stations; two are operated for Goddard by the Weapons Research Establishment of Australia, and the remainder are handled for Goddard by the Department of Defense.

John T. Mengel
Assistant Director, Tracking and
Data Systems Directorate
Goddard Space Flight Center
NASA
Greenbelt, Md.

Weightlessness Tests

To the Editor:

I read in the Dec. 11 M/R (p. 42) that Douglas Missile and Space Systems Division is now simulating weightlessness on the human body by supporting it with an assembly of balloons. I have in the past read of submergence techniques which accomplish the same thing, supporting the body with hydrostatic pressure.

Unless I miss my guess, both of these techniques are all wet—at least in some respects. True weightlessness is accomplished by relieving the inside of the body of all pressure gradients, and neither fluid support nor balloons will do this. No matter how the body is supported, if it remains in a g field the inner tissues are subjected to stress, blood pressure must work through a gradient, and the balance organs are affected.

I would certainly like to know of the philosophy behind such testing. Perhaps some of your readers can enlighten me.

C. W. Lear
Space Technology Labs
Redondo Beach, Calif.

Technical Meetings

To the Editor:

It is very seldom that I will write to a publication regarding an editorial but I have just finished reading yours entitled "On Booze, Blondes and Bashes" which appeared in the October 23 issue of MISSILES AND ROCHETS. This is a very excellent editorial and points out a problem that is becoming more serious and more complex for most manufacturers. The basic premise of a trade show is excellent, and they can do much good in promoting the state of the art. However, they are becoming so numerous and so costly that I personally question the advantages that accrue to the exhibitor.

You are to be congratulated for your forthright statements on this situation.

R. J. Hippert
Advertising Manager
Cannon Electric Co.
Los Angeles, Calif.

To the Editor:

Your editorial "On Booze, Blondes and

and Bashes" and subsequent letters to the editor have been read and my amen is also added.

As a representative, I would like to see my principals exhibiting at trade shows.

However, the carnival atmosphere of far too many shows has caused them to usually limit themselves to participation in strictly regional shows (e.g., Boston area principal exhibiting in NEMREC).

Then, too, the fact that some companies have what appears to be a traveling road show is discouraging to smaller companies who would have to use their regular engineering staff to man the booth at a trade show.

So here's to the day when technical meetings again become truly technical meetings, wherein companies of all sizes, and from all parts of the country, will exhibit.

Philander Chase Knox
East Coast Liaison, Inc.
Lutherville, Md.

NASA Issue Reprints

To the Editor:

Your Nov. 27 NASA issue was outstanding. Is it possible to obtain reprints of the editorial section?

NASA is charged with the responsibility for the Nation's civilian or "peaceful" mission in Space. But what about our military role? Isn't this far more important at this time? And when will you present to the industry a complete take-out on the U.S. military space effort?

George Johnson
San Jose, Calif.

Reprints of the editorial section of M/R's Nov. 27 NASA Special Issue are available at $1 each ($.75 each for 11 or more) by writing the Marketing Dept., Missiles and Rockets Magazine, 1001 Vermont Ave. N.W., Washington 5, D.C.

M/R has consistently backed a strong U.S. military space effort; its 2nd Annual Research and Engineering Issue, to be published March 26th, will be titled "Military Space Systems", and has been set up as a follow-on or companion piece to the NASA issue.—Ed.

Goddard Trophy Proposal

To the Editor:

If I recall correctly, M/R presents the Dr. Robert H. Goddard Memorial Trophy each year to the missile/space industry's outstanding individual.

Is it possible for subscribers to nominate candidates? If so, let me propose the names of Alan Shepard and Virgil Grissom, the first U.S. Astronauts, for a joint award.

When and where will the trophy be presented this year?

Richard M. Edwards
Dayton, Ohio

Nomination duly noted; others are welcome. The Goddard trophy will be presented March 16 at the Doctor Robert H. Goddard Memorial Dinner, highlight of the 5th Annual Missile/Space Industry Conference, to be held in Washington, D.C. at the Sheraton-Park Hotel.—Ed.

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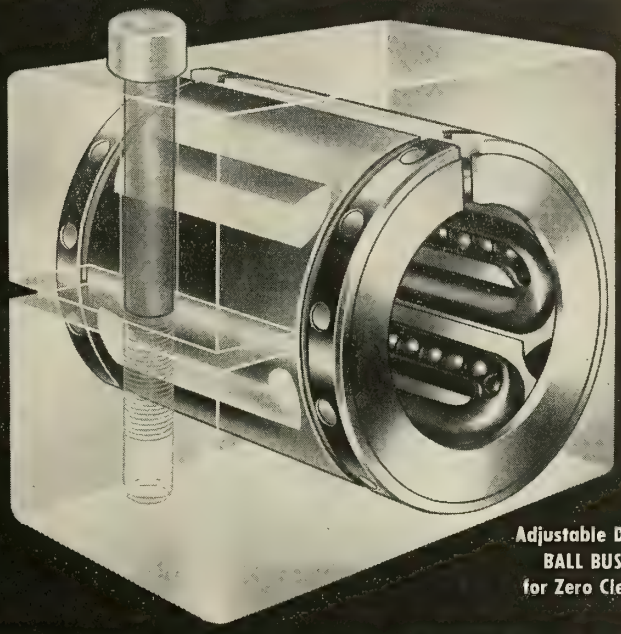

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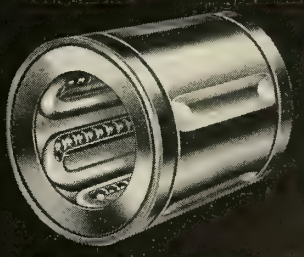

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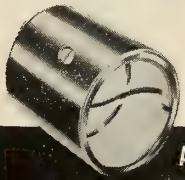

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The Countdown

WASHINGTON

NASA Looks into the Crystal Ball

Officials at NASA are feverishly preparing a revised 10-year space plan for presentation at the new session of Congress. Some 500 charts, pictures and drawings will be included. So will the first official statement on the record that NASA expects to land an astronaut on the moon in the 1966-67 time period.

New Navy Satellite Readied

The Navy is preparing for a first launching of a new instrument-crammed satellite called *Composit I*. Few details of the new satellite are available. However, it is expected to involve the use of the piggyback technique often employed by the Navy. The launching is planned for later this month from Cape Canaveral.

AEC in Space

The Atomic Energy Commission is being tapped for a much larger role in the nation's space programs over the next several years. The first step is understood to be a substantial increase in its FY '63 budget for R&D on nuclear propulsion—primarily the *Rover* program.

Iconorama at the Pentagon

The Pentagon's underground command post is now plugged into the nation's missile-air defense warning net via an Inconorama visual display screen. Similar Inconorama display systems are in use at NORAD's command post at Colorado Springs, Colo., and SAC's command post at Offutt AFB, Neb.

Spacecraft Name Dept.

The NASA *Apollo* spacecraft will come under three handy labels: *Apollo A* (for earth orbiting); *Apollo B* (for moon orbiting); *Apollo C* (for moon landing). So far, the current NASA contract with North American Aviation for 10 to 15 spacecraft covers only *A* models.

INDUSTRY

G-D Leads R&D Contractors

General Dynamics, with awards of $577 million, topped DOD contractors in R&D work during FY '61. Lockheed was next with $576 million and North American third at $505 million. The next seven: General Electric ($384 million), Martin Marietta ($319 million), Boeing ($291 million), Western Electric ($279 million), Aerojet-General ($193 million), Thiokol ($151 million), and Westinghouse ($149 million). Total R&D awards hit $6 billion — up $500 million from FY '60. Five hundred contractors received 98.8% of the total.

R&D Intelligence

There's progress in the Army's *Advent* communications satellite program with the completion of the first two ground antennae receiving stations at Ft. Dix, N.J. *Advent's* first launch is set this year. . . . Kollsman Instrument is developing a 38-in. primary mirror telescope in the 900-4000 angstrom region to go aboard NASA's *Orbiting Astronomical Observatory*. . . . Look for another *Argo D-4* rocket test shot before NASA tries to orbit the international *S-48* Topside Sounder satellite. . . . The Naval Ordnance Laboratory says it has compiled the first comprehensive high-precision measurements of the speed of sound in seawater into a standard reference guide.

Merger Sequel

Retired Air Force Gen. John W. Sessums, Jr., has been replaced as chairman of the Lockheed Propulsion Co. by Lockheed Aircraft President Daniel J. Houghton. The move followed Lockheed's complete takeover of Grand Central Rocket Co., renaming it Lockheed Propulsion. As for Sessums, the company says he will stay on as a board member with a "broadened scope of activities"—including acting as a consultant.

Missile Base Inquiry Brewing

The Senate Permanent Investigations Subcommittee is reported to be preparing for a new inquiry into the Air Force's huge ICBM base-building program. This new go-round would involve a closer look at management's role in the much-delayed construction and installation projects. One subcommittee target is expected to be quality control.

INTERNATIONAL

Seaslug I To Join the Fleet

The Royal Navy is about to send the W. G. Armstrong Whitworth *Seaslug I* to sea aboard the first of Britain's new County Class guided missile destroyers—the HMS Devonshire. The new ship officially joins the fleet this summer. However, other County Class destroyers scheduled to carry *Seaslug I's* are not expected to join the fleet before 1964—some nine months before *Seaslug II* is scheduled to become operational.

Overseas Pipeline

NATO officials have accepted the first European-manufactured *Sidewinder*. . . . SEPR is reported to be testing a liquid fluorine rocket engine . . . the German Test Establishment for Aeronautics and Spaceflight is establishing an Institute of Space Research. . . . Nord's *Vega* ramjet has been undergoing unannounced testing in the Sahara.

Behind the Bamboo Curtain

Reports coming out of Red China blame part of the growing Moscow-Peiping dispute on Soviet refusals to give the Chinese Communists technical assistance in building missiles. The Red Chinese are reported to be seeking surface-to-surface missiles capable of spanning Formosa Strait.

Atlas Snags Orbital Shot

Troubles in the *Atlas* booster have apparently delayed until Jan. 23 or later the first U.S. manned orbital spaceflight.

Informed sources at Cape Canaveral said that the trouble cropped up overnight. NASA officials in Washington refused to confirm or deny the report.

Earlier, the shot reportedly was slated to go about Jan. 16. The *Mercury* capsule was only installed on top of the booster on Jan. 3. It will take at least two weeks to check out the capsule.

Shots of the Week

The Air Force's *Titan II* was captive fired for the first time Dec. 28 in a test aimed at reducing ballistic missile development time by a year.

The test, using GSE designed for use at operational *Titan II* bases, was made at Martin Marietta's Denver facility.

A company spokesman said "In the past, we moved one step at a time during the initial research and development phases. Our success with the *Titan I* gave us the experience necessary to test the operational ground equipment along with the very first *Titan II* flight vehicles."

The two-stage rocket generated over one-half million pounds of thrust while checking compatibility of the airborne and launch control systems.

On the same day, Martin also fired the Army's *Pershing* successfully down the Atlantic Missile Range.

Foxholes and barricades shielded instrumentation that measured heat and blast effects created at liftoff. Data will be used to determine safety requirements needed for *Pershing*-firing troops.

Vela Data Center To Be Constructed

ARPA is planning the construction of a multimillion-dollar data analysis center in the Washington Area as part of the Project *Vela* nuclear blast underground detection system.

The *Vela* Data Analysis and Technique Development Center will be designed, installed and operated by United ElectroDynamics, Inc. The

LOCATION of Vela Uniform seismic laboratory, to be built near Payson, Ariz.

center—scheduled to go into operation this June — will evaluate data from the entire *Vela* network of 40 fixed and mobile seismic recording stations.

The UED contract is for $1.5 million. It is expected to increase to about $3 million over the first 21 months.

UED also is the prime contractor for installing and operating the *Vela Uniform* seismic observatory at Tonto National Forest, Ariz.

NASA Space Flight Council

D. Brainerd Holmes is heading up a new management council of top NASA officials. Holmes, director of the Office of Manned Space Flight, says the council is intended to identify and resolve problems as they crop up in the manned space program, which is directed primarily at beating Russia to the moon.

Other members of the committee include: Robert R. Gilruth, Director of the Manned Spacecraft Center; his Deputy, Walter C. Williams; Dr. Wernher von Braun, Director of the Marshall Space Flight Center; Dr. Eberhard F. M. Rees, Deputy Director for Research and Development at Marshall; George M. Low, Director of Space Craft and Flight Missions; Milton W. Rosen, Director of Launch

COVER STORY

Army Gets First PIM Space Tracker

AN ACCURATE, rugged space tracking system—named the Precision Instrument Mount (PIM)—has been developed by the Army's Signal Research and Development Laboratory at Fort Monmouth, N.J., Army officials announced recently.

The electromechanical system, on which the Army worked jointly with American Machine and Foundry Co., is capable of recording the position of space objects to an angular accuracy of 180th of a degree and a time coordinate of one-thousandth of a second.

Tracking is accomplished automatically, semiautomatically or manually by the operator. PIM incorporates the basic features of a phototheodolite, according to the Army, through the use of a sighting telescope and camera. However, the system provides new capabilities—including television for remote operation and heat-sensing infrared or radar sensors for tracking objects out of the operator's sight.

PIM—having successfully passed the Army's acceptance tests —is currently undergoing operational tests at White Sands Missile Range. It is expected to add greater flexibility to the tracking facilities at WSMR when it is fully operational.

Under the initial contract, three more Precision Instrument Mounts will be built for Army use.

Vehicles and Propulsion; Charles H. Roadman, Director of Aerospace Medicine; William E. Lilly, Director of Program Review and Resources Management; and Joseph F. Shea, Deputy Director for Systems Engineering.

Excess Profits Far Down

Renegotiation Board excess profit determinations hit the lowest yearly volume in nine fiscal years during FY 1961—$17,200,093.

In its annual report to Congress, the Board said it made 68 determinations of excessive profits, raising the cumulative total of all such findings to $853,721,027 through June 30, 1961.

Of the 68 determinations, the Board said 51 resulted in bilateral agreements with the contractors and 17 in unilateral orders for refunds to the government.

During the fiscal year, contractors voluntarily refunded $31.5 million, hiking the volume of voluntary refunds through June 30 to $1.1 billion.

Total recovery by the government under combined determinations and voluntary refunds amounted to some $24.6 during the fiscal year. This total is minus $24 million in probable tax credits.

Rudolph, Shea Get NASA Posts

Dr. Arthur Rudolph and Dr. Joseph F. Shea have been appointed to top NASA positions at the Marshall Space Flight Center and Headquarters.

Shea was named Deputy Director for Systems Engineering, Office of Manned Space Flight in NASA Headquarters. He was formerly Space Program Director for Space Technology Laboratories.

Rudolph—former Director of Research and Development Operations for the Army Ballistic Missile Agency—has assumed duties as Assistant Director of Systems Engineering for NASA's Office of Manned Space Flight. He will serve as liaison between the Marshall Space Flight Center at Huntsville, Ala., and the Manned Spacecraft Center at Houston.

Seismometer for Ranger

The scientific package on *Ranger* flights RA-3, -4 and -5 will include a single-axis seismometer capable of withstanding an impact of about 5000g.

Caltech's Jet Propulsion Laboratory says the seismograph may help provide insight into the thermal history and deformation processes operative on the moon. The basic instrument consists of a coil, a spring-suspended magnet, and an internal calibration device. Natural period of the instrument is 0.9 to 1.2 secs. Damping of the seismic mass upon lunar impact will be provided by a caging fluid. The electrical analog signals generated will be amplified and telemetered to earth by FM/PM.

Rigid Echo Readied

NASA prepared this week to launch the first rigidized version of the *Echo* passive communications satellite on a ballistic shot from Cape Canaveral designed to test its ejection and inflation systems.

The 135-ft.-dia. satellite will be boosted to an altitude of about 950 statute miles and almost 600 miles downrange.

Flight results will be applied to later *Echo* satellites and Project *Rebound*. An *Echo* satellite will be placed in a 900-mile-high polar orbit later this year. The first *Rebound* launch—scheduled for 1963—will place three satellites into orbit with one launch vehicle.

The rigidized version of *Echo* is expected to increase both its life and effectiveness. The non-rigid *Echo I*, launched Aug. 12, 1960, has lost 60% of its effectiveness in reflecting signals because it has lost it spherical shape. NASA scientists expect the rigidized version to retain its shape.

A single-stage *Thor* rocket will boost the 500-lb. sphere.

Correction

In a picture caption and an accompanying article on page 11 of its Jan. 1 issue, Missiles and Rockets inadvertently named B. F. Goodrich Co. as participating in NASA's erectable space station program. The correct contractor and developer of the expandable space station models is the Goodyear Aircraft Corp.

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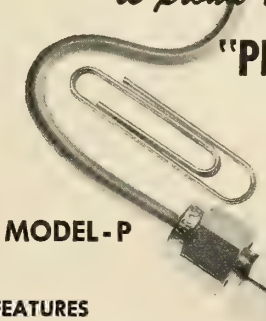

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Space Council Unifying Goals

In nine months of operation, top-level group has already done much to develop cooperative national effort

by James Baar

THE WHITE HOUSE-blessed National Space Council is slowly bringing about a quiet revolution aimed at unifying the overall goals and direction of U.S. space programs. The prime target: Ensuring national security.

At the same time, the Council's increasingly influential role in helping shape U.S. space policies is expected to be one of the most significant Administration trends in 1962.

The thinking underlying many current Council recommendations was best summed up in an interview this week with its executive secretary, Dr. Edward C. Welsh. He said:

—"We want to continue to develop working and planning in terms of a national space program."

—"We are attempting to dissolve artificial distinctions between peaceful and non-peaceful uses of space. All of our programs are peaceful. The Defense Department's activities are to maintain the peace; NASA's are to enable us to live better in peace."

—"We want to maintain a sense of urgency. There is always the danger that one can lag."

If successful, these policies will result in a reversal of the more-than-two-year-old trend in which the bulk of the nation's space effort has been invested in so-called peaceful projects and so-called non-peaceful projects have been starved for funds.

In place of this, administration officials would put together a national space R&D program aimed at fully developing all of the technical capabilities needed for fulfilling present and future space missions of the Defense Department and NASA.

• **New approach** — Some major moves in this direction already have been made within the nine months that the Council—never used by the Eisenhower Administration—has been operating. One of the most important was the manner in which President Kennedy made his second revision of space program budgets last May.

The preceding month the President ordered the Space Council to review the nation's space programs with the aim of outstripping Russian progress in astronautics. The Council's recommendations were presented to the President as a national program covering the work of all government agencies, and the subsequent Administration proposals were sent to Congress in a similar manner.

This pattern has been maintained by the Council in reviewing proposals in the FY '63 budget—that will be sent to Congress within the next several weeks.

Another important—and more difficult—move has been the arrangement and encouragement of cooperation between NASA and the military services as well as other agencies particularly on the working level.

Details in this area are still far from having been worked out. But the pressure to do so is being maintained.

• **Many masters** — Meantime, the Council has been extremely active in a number of other controversial areas.

One is the drafting of the Administration's policy on commercial communications satellites and later the drafting of the Administration's ComSat bill which will be sent to Congress this month. The bill is expected to provide authority for a broad-based private corporation to operate the commercial system.

Three other areas of Council activity have involved it in helping to standardize space patent provisions; clearing the way for the first launching of a SNAP nuclear power unit into orbit, and studying the nation's aerospace medicine facilities.

These represent the three points from which the Council receives assignments in its overall mission of keeping tabs for the President and advising him on the nation's space and aeronautical projects. The President asked for the work on communications satellites; the AEC on SNAP; the Council, itself, on aerospace medicine.

• **Few workers**—Despite the considerable ground that the Council has covered since last spring, it is only within the last several months that it has operated with anything approaching more than a skeleton staff. In the spring when the budget was being revised, the staff was virtually one man—Welsh, who operated out of a borrowed office with a borrowed secretary.

At present, the Council has a total staff of about 12 people, of which seven are professional "aerospace assistants," a Welsh-coined title. At the most, the staff is not expected to be more than doubled in the future.

As now constituted by law, the Council is comprised of Vice President Lyndon Johnson, who is chairman; Defense Secretary Robert McNamara; Secretary of State Dean Rusk; NASA Administrator James Webb; and AEC Chairman Glenn Seaborg.

However, because each Council member wears two hats, it is inevitable that only the Vice President and Welsh become the Council's principal space policy advisers, and the Council as a group acts more as a coordinating board.

• **High optimism**—So far, Welsh feels the new system is working well. He has had good cooperation: he receives regular reports from the agencies and when he wants additional information he and his staff are provided it.

But, even with complete cooperation, a huge program that is spread throughout so many agencies can contain innumerable pitfalls and room for foot dragging and misunderstanding. Obviously, one problem continues to be a broad agreement on goals especially relating to national security.

"We are trying to develop an increased awareness of the uses of space for defense purposes," Welsh said, sitting at his desk in the Executive Office Building. "If we have this rather than a feeling of rivalry, then you can have a much smoother operation."

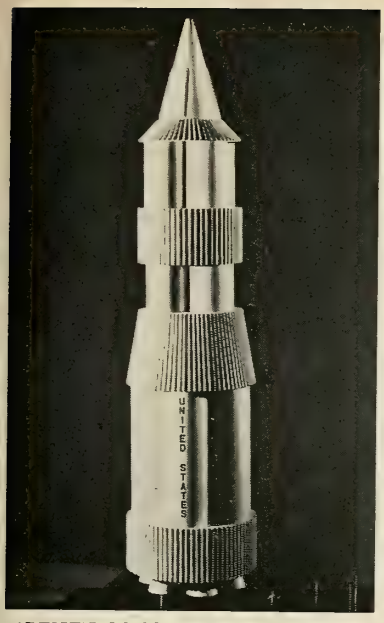
He said he was optimistic that the Council will be successful in carrying out its policies and made clear that his optimism is based to a great extent on the support of his staff at the highest level of the Administration.

"After all," he said, "the Vice President is the chairman and it isn't just incidental that I carry a White House pass." ⁂

by Hal Taylor

NASA Plans Push To Get Three-Stage Nova

Congress willing, first industrial contracts for vehicle may be let after July 1; reports of scrapping discounted



ARTIST'S CONCEPT of three-stage Nova configuration now being planned for.

AFTER MUCH deliberation NASA is planning to move ahead with hardware development of the *Nova* superbooster in 1962.

Prospects for the multimillion-dollar moon rocket—long considered dubious—now seem measurably improved. But the actual commitment of funds still must await congressional approval of NASA's FY '63 budget.

If present plans hold firm, NASA expects to award industrial contracts for the *Nova* vehicle sometime after July 1. The booster will have three stages, requiring development of two brand-new multimillion-lb.-thrust upper stages, as well as the first stage.

No final stamp of approval has been given to the vehicle's design. But Milton R. Rosen, director of launch vehicles in the agency's Office of Manned Space Flight, told MISSILES AND ROCKETS in an interview that *Nova's* configuration now shapes up like this:

—**First stage**—Eight Rocketdyne F-1 engines with a thrust of 1.5 million lbs. each or a total thrust of 12 million lbs.

—**Second stage**—Either two or four M-1 liquid hydrogen engines which will have a thrust of from 1 to 1.5 million lbs. each (M/R, Jan. 1, p. 10). Another possibility, although slight, calls for the use of eight J-2 engines, 200,000 lbs. thrust each.

—**Third stage**—One J-2 engine, for a total stage thrust of 200,000 lbs. This is the same as the third stage of the *Saturn C-5* vehicle for which the Douglas Aircraft Corp. has the contract.

Nova would be used to send the entire *Apollo* spacecraft—which may weigh as much as 150,000 lbs.—directly to the moon and back.

For that mission, Rosen said, *Nova* as presently planned would not be marginal, but would have more than enough capability.

• **No scrapping**—Rosen effectively discounted published reports that NASA intends to scrap *Nova* and place all its hopes for achieving a manned lunar landing on the *Saturn C-5* and orbital rendezvous. He said *Nova* definitely is needed and that the U.S. space program cannot be pushed without it.

He said that while orbital rendezvous may be the best bet for the lunar landing flight, any follow-on programs will require a *Nova*-class vehicle.

He added that it is a necessity if the U.S. intends to establish a moon base or undertake manned exploration of the planets.

The selection of a contractor for *Nova's* first stage will be made following industrial competition similar to that for the recent *S-1B* award, approximately 30 firms will be invited to a preproposal conference. Interested firms will then submit bids.

The same procedures may not be followed in the development of the new M-1 engine, because NASA feels far fewer firms are qualified to build it. While Rosen said that no final decision had yet been made, informed sources report that the go-ahead announcement for the engine is imminent.

• **Engine choice**—The number of engines which will be used in a *Nova* second stage will depend upon a final decision as to the total thrust of each engine. If a 1-million-lb. or slightly higher thrust engine is built, four would be clustered. If the engines' thrust approaches the 1.5 million range, only two would be needed.

An engine-out capability would also require four engines. Total second stage thrust could run from 3 million to 4 million lbs.

Rosen also said that if the *Nova* stages are built at NASA's Michoud plant—which appears likely—plant extension and additional facility construction will be required. He indicated that if any other plant site is chose, it will have to be in a 100-mile radius of the New Orleans area, where NASA is presently concentrating big launch vehicle development and test-firing.

The thrust of the *Nova* booster could also be sharply upgraded if nuclear upper stages are added later on. NASA officials now estimate that the *Rift* nuclear stage will be test-flown in 1966-67, but it is almost certain that it will not be ready for manned flight until 1968-1969.

NASA, however, is moving ahead with procurement procedures for the vehicle. January 8 is the deadline for submission of proposals by industrial firms who want to be considered in the selection of a prime contractor. In about two to four weeks, NASA will announce the firms invited to submit detailed development bids.

Also expected in the near future is the announcement of a contract for further development of the *Nerva* nuclear engine which will power the *Rift* stage. Westinghouse Electric Co. and Aerojet-General Corp. have the current contract and it is likely they will be awarded the new extended contract. ⌘

No precise dimensions . . .

First Designs of Apollo Lunar Craf

Gemini closely resembles Mercury, but Apollo will have wider module and a blunter nose than expected

NASA UNVEILED its first design sketch for the *Apollo* lunar spacecraft last week, along with ones for the two-man *Mercury* follow-on which it has named Project *Gemini*.

The sketches show the $500-million *Gemini* program capsules will be the same shape as *Mercury* (M/R, Dec. 18, p. 13), but that the *Apollo* service module will have a wider diameter than previously indicated. The *Apollo* re-entry vehicle shape, moreover, is much blunter than test models and some of the configurations proposed by contractors.

Gemini will be used as a test bed for orbital rendezvous flights and for manned flights of a week or more. Its name stems from the third zodiacal constellation, the twin stars Castor and Pollux.

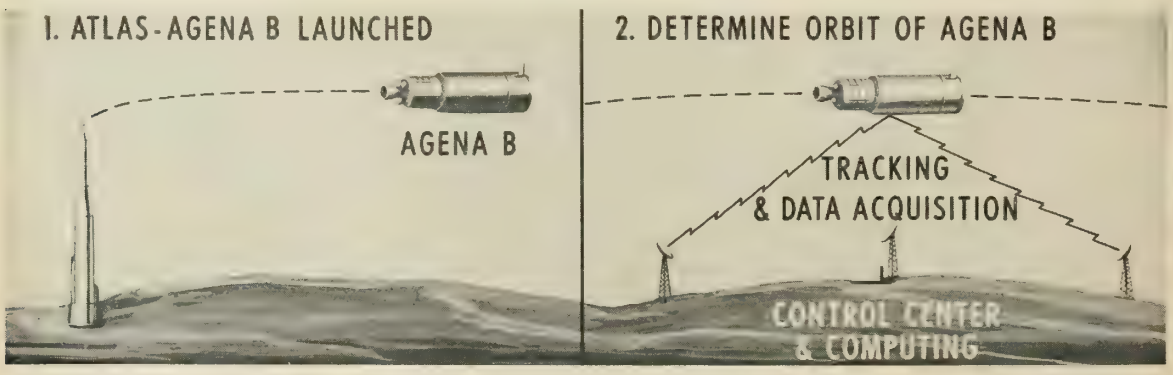
Apollo will carry three U.S. astronauts on earth-orbiting and circumlunar missions, and a manned landing and return from the moon.

• **Apollo's outline** — Space agency officials have not revealed precise dimensions for either *Apollo* or *Gemini*. But it is reported that *Apollo* will weigh between 100,000 and 150,000 lbs. It will be 15 ft. to 20 ft. high and about 60 ft. long. The command and service modules shown in the drawing will be 12 to 15 ft. in both length and diameter. The propulsion (lunar landing) and orbiting laboratory modules—not shown—will be about 30 ft. long.

COMPARISON of Mercury and Gemini manned vehicle designs.

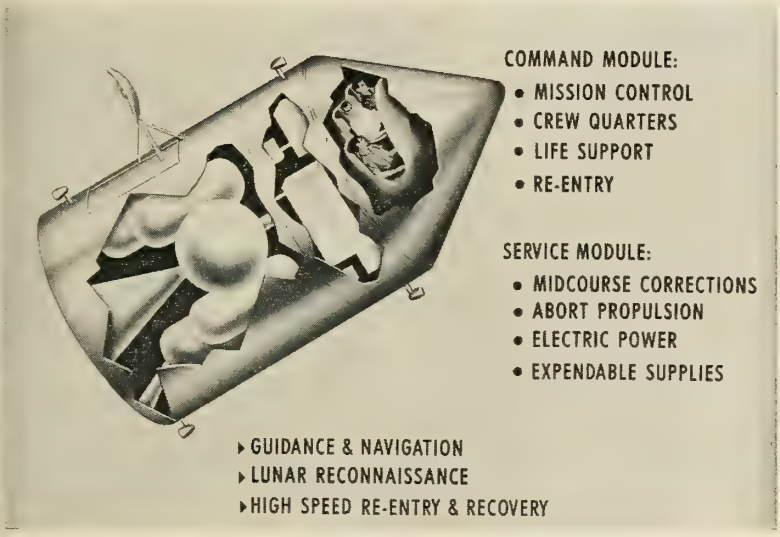
The spacecraft's three-man crew will sit side by side. The service module—as the drawing indicates—will contain the propulsion units necessary to lift the spacecraft from the lunar surface and power it on its return trip to the earth.

The *Apollo* capsule will be launched by the *Saturn C-5* and *Nova* boosters. An official announcement of the selection of the *C-5* as the booster for possible orbital rendezvous flights to the moon is imminent. The disclosure is being delayed until the space agency can come up with a new name for the launch vehicle which will have five F-1 engines developing 7.5 million lbs. thrust. Development of the *Nova* ve-



SEQUENCE OF PROJECT GEMINI FLIGHT MISSION.

ınd Gemini Two-man Capsule Shown



CIRCUMLUNAR CONFIGURATION of Apollo spacecraft.

hicle has not begun yet, but is slated to move ahead in mid 1962.

Apollo is scheduled for earth-orbital flights in 1965, circumlunar missions in 1966, and a manned lunar landing in that year or in 1967.

• **Family likeness** — The *Gemini* spacecraft—as illustrated in the other NASA drawing—will also seat its two-man crew side by side. Several unmanned ballistic flights will be attempted with the spacecraft in 1963. Then a series of one-day, three-day, and one-week manned flights are scheduled. The orbital rendezvous missions will come late in 1964.

In essence, *Gemini* is an enlarged but far more complex version of NASA's current *Mercury* capsule. It will be 1 ft. larger than *Mercury's* 74-in. base and it will be lengthened proportionately to provide a 50% increase in cabin space. It will be two to three times as heavy as *Mercury*, weighing about 4000 lbs. during its early flights and 6000 lbs. during the rendezvous missions.

The Martin Marietta Corp.'s *Titan II* booster will be used to launch *Gemini* on all of its flights. Its second stage will be uprated from 15,500 to 17,500 miles per hour to furnish the necessary thrust capability.

In the rendezvous operation, the *Agena B* will be launched by an *Atlas* booster into a 150-mile nautical orbit. It will be tracked for approximately one day to determine precise orbit.

The information will then be fed automatically into computers to determine the exact time that the *Gemini* spacecraft should be launched.

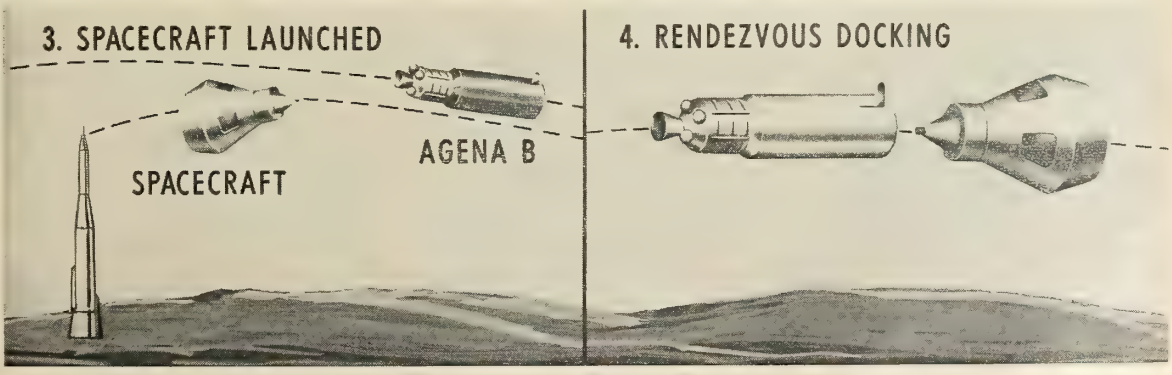
Its *Titan II* booster will send the spacecraft into an elliptical earth orbit which will vary from 100 to 150-mile-high altitudes.

When the spacecraft is in apogee, it will be in the same orbit as the *Agena B*. As soon as possible, the spacecraft's pilot will lock on the *Agena B*. To do this, the pilot will utilize air-to-air sensors, transponders and electromagnetic sensing devices.

Once he is locked on the *Agena B*, the closing phase will begin with the firing of the spacecraft's hypergolic engines.

Prior to re-entry, the *Agena B* will be jettisoned.

McDonnell Aircraft Corp. has won the contract to develop the *Gemini* spacecraft and North American Aviation Inc. has the prime contract for *Apollo*. ⁂



Second in a series . . .

Expedition to Saturn: Can Men Com

Back from the Outer Planets?

STEPS BEYOND MARS

THIS IS THE SECOND in a series of articles examining the problems which must be solved before man can send probes or himself to explore the outer planets. The first—probing Jupiter—appeared in the Dec. 4 issue.

Robert L. Forward, the author, is a physicist at Hughes Research Laboratories, now on leave to pursue advanced studies at the University of Maryland. He has published a number of papers on masers, radar antenna noise and general relativity.

Two more articles in the series indicating the advances needed to reach the "twins"—Uranus and Neptune—and, finally, Pluto, will appear in forthcoming issues.

by Robert L. Forward

←

"STORM CELLAR" proposed by author would employ superconducting electromagnetic coils to shield astronauts from solar protons during interplanetary journeys. Artist's concept shows protons being repelled by magnetic field while others riddle normal living quarters. "Cellar" would be used only during periods of solar flare activity.

ONCE MAN SUCCEEDS in exploring the planet Jupiter, he should within a few years be ready to take a second major step—900 million miles to Saturn.

It can be assumed that throughout the preparation for an expedition to Jupiter new ideas and devices will have been developed, making the Jupiter vehicle look obsolete before it leaves its parking orbit. Spacecraft for such long journeys must be built from proven hardware, for round trips to these outer planets will take years.

• **The planet**—When one looks at Saturn through the telescope, the rings attract the eye, leaving the yellowish globe itself nearly unnoticed. Basically, however, Saturn is not too much different from Jupiter, except in size. Saturn has cloud belts and roving spots, but all the markings are more subdued and less violent in their motion than their counterparts on Jupiter. A broad yellow band encircles Saturn's equator and there are greenish-yellow caps over the polar regions.

Although Saturn is quite large in volume, it has a comparatively small mass. In fact its density is only two-thirds that of water! Its short rotation period of 10 hours combined with the low density causes Saturn to be quite elliptical in shape. A model of the planet proposed by Wildt consists of a rocky core of 28,000 miles, an ice layer extending out 8000 miles and a hydrogen-methane atmosphere 16,000 miles thick.

Saturn is almost twice as far from the sun as Jupiter. Its upper atmosphere is therefore colder, and more of the ammonia is frozen out.

• **Can men land on Saturn?**—For all the outer planets, the feasibility of manned exploration is determined mainly by whether or not a return trip can be launched up from the surface. The construction of a rocket that can attain the necessary orbital velocity of 16.2 mi./sec. about Saturn is not a trivial project.

Although the escape velocity is high, the surface gravity is not. The surface gravity depends not only on the mass of the planet, but also on its radius. Because of Saturn's low density, the gravitational attraction at the top of the atmosphere is only 1 g. If we accept the Wildt model, the gravitational attraction at the ice surface is still only 2.7 g's. Thus, manned exploration of the surface, although difficult, is not ruled out by gravity.

• **Saturn's rings**—The most striking feature of Saturn is its ring system. The rings consist of many millions of small solid particles, each in its own orbit about Saturn. The sizes are not known, but due to the high reflecting power of these particles, it is presumed that they are quite small, most of them being the size of grains of sand. The reason that the particles have formed into rings rather than a moon is that their orbits are inside the Roche limit. Solid bodies of any size cannot orbit too close to a planet without being pulled apart by the differences in gravitational pull on the near and far side of the body.

The fact that there are rings rather than a single ring is the result of the perturbations on the particles in the rings by the three inner satellites, Mimas, Enceladus, and Tethys. These satellites force the small particles in the rings to avoid certain speeds in moving about Saturn, with the result that dark spaces show at the critical distances.

Cassini's division, the conspicuous dark space between the outer and middle rings, covers a region in which the tiny particles would move with a period of eleven hours. This period is one half that of Mimas, one third that of Enceladus, and one quarter that of Tethys. Other expected dark gaps can also be observed.

The reason for the gaps is easy to see. Let us take the case that three revolutions of the particle require exactly the same time as two revolutions of Mimas. Whatever perturbations are produced in three revolutions of the particle will be duplicated in the next three revolutions, and so on, eventually changing the orbit materially. The process is similar to that occurring when an automobile passes over a series of equally spaced bumps in the road.

A similar case involves Jupiter and the asteroid belt. A curve of the num-

(Continued on page 38)

VITAL: command and control systems which collect, transmit, process and display information to military commanders responsible for compressed-time decisions.

THE MITRE CORPORATION

is now engaged in designing and developing computer-based command and control systems which collect, sort, transmit, and display information vital to those who make command decisions. SAC's Command and Control System, SAGE, BMEWS, NORAD, MIDAS and other urgent military programs are all within the scope of MITRE's system integration work.

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- **Computer Technology**
- **Mathematics**
- **Air Traffic Control System Development**
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echnical Countdown

ELECTRONICS

e of MM-IR Range Sought

Theoretical studies of the millimeter-infrared portion of e electromagnetic spectrum have been initiated by Page mmunications Engineers, Inc. Little is known concerning thods for generating or receiving signals at such wave-gths (0.0001 to approx. 1.0 mm)—just below that of the west frequencies producible by lasers. Page is investigating e possibility of generating phonon waves and transducing em to electromagnetic waves instead of attempting direct ctromagnetic-wave generation. The problem is to achieve ole-body interaction using phonons at mm-IR wave-ngths. Coherent mm-IR signals might offer a whole new nd for communications, Page scientists believe. Thermal ects of a coherent mm-IR beam might also be used as a structive beam for antimissile defense.

ew Computer Element Developed

A multiple-shift register and pseudo-random noise gen-ator using a single tunnel diode for each stage has been sted successfully by Martin Marietta. Developed by the mpany's Electronic Systems and Products Division in altimore, units have been operated at a 100-mc clock rate. igher rates will be possible soon, Martin engineers said.

OPTICS

IASA Awards New OAO Contract

Kollsman Instrument Division has just received another &D and production contract for NASA's *Orbiting Astro-omical Observatory (OAO)*. The recent $1-million award is r a 38-in.-dia. primary mirror in the space telescope. It so includes an ultraviolet-range spectrometer with asso-ated signal processing and other electronics. Under an rlier subcontract to General Electric, Kollsman is supply-g the fine-stabilization star trackers for all the *OAO* ve-icles.

ardinia Range Buys Three Igors

Vitroselenia of Rome will purchase three large tracking lescopes for the Italian Air Ministry from J. W. Fecker iv. of American Optical Co. The Igor Mark III's, modified rsions of Fecker's standard 18-in.-aperture optical sys-m, will employ a Contraves drive system. The instruments ave multiple focal length and automatic exposure and focus ntrol. The contract, believed in excess of $600,000, calls r installation of the instruments at the Sardinia Missile est Range by late summer.

ptical Tracking System Used for Titan

A specially-designed glass refractor—mounted on the in of a *Titan I* ICBM—is being used to track and photo-aph the missile flight, Corning Glass Works developers an-unced recently. The refractor-reflector system, they re-rt, enables the light from a 22-million-peak-candlepower non lamp which flashes on and off at half-second intervals be photographed by ground stations with special ballistic meras. The refractor glass—a berosilicate compound—is sily formed, hard and heat-resistant.

SUPPORT EQUIPMENT

Saturn Umbilical to Be Extended

The umbilical tower at NASA's *Saturn* Launch Complex 34 at Cape Canaveral will be extended from its present 27-ft. level to its full 240-ft. length, space agency officials announced recently. Tapering upward from a 24-ft. base, the tower will be 10 ft. square at the top and will carry the electrical, pneumatic and hydraulic connections used in fueling and servicing the multiple-stage *Saturn*. Work platforms will be located at 20-ft. intervals on the structure.

NBS, Navy Change Standard Frequencies

On Jan. 1, the National Bureau of Standards and the U.S. Naval Observatory boosted standard frequency transmissions by 2 parts in 1 billion. Necessitated by irregular variations in the earth's speed of rotation, the change will result in higher precision in scientific measurements, satellite tracking, radio communications and navigation, NBS said.

ADVANCED MATERIALS

Resistor Noise-Correlation Found

Engineers at Corning Glass have found a fast means of predicting temperature coefficient and life performance in three tin-oxide film resistor types. The determination is based on a correlation between current noise and electrical performance and supported by measurements on thousands of resistors.

Inflatable Bags Aid Solid Motor Production

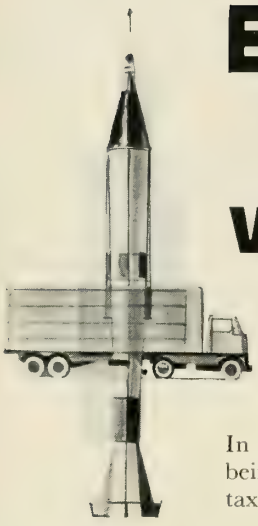
Cylindrical, inflatable bags designed by Garrett Corp.'s Air Cruisers Division hold slivers of inert material firmly against the walls of motor cases during preparation stages at Thiokol Chemical. The development permits the bonding of the slivers to the case wall and eliminates the necessity for bolts. The uniform pressure exerted by the bags results in a uniform thickness of bonding material.

New Aft Insulation for Minuteman?

A molded all-rubber internal case insulation may replace plastic segments in the insulating of *Minuteman* first-stage aft closures. The units are molded in one piece from Hitco 6520, a silica dioxide-loaded Buna-N rubber, by Dumont Manufacturing Corp.

Ceramic Raw Materials Upgraded

Specially processed flint, silica, sand and pure kaolins for the glass and ceramic industries soon will be available from Gladding McBean & Co., Glendale, Calif. Part of the firm's diversification program, the raw materials benefaction process to make minerals, non-metallics and ores more usable, will begin in 1962 with completion of a new processing plant at Ione, Calif. The company also produces ceramic radomes for *Sparrow III*.



EXPECT MORE from your next weapons system

In our world, a defense system cannot be merely adequate. We cannot risk being second best. We cannot afford to demand less than full value for every tax dollar spent.

Industry's job is to grasp the full implication of the mission, to design and build the system to meet cost requirements and delivery schedules. And to *insure* that it will perform when the buttons are pressed.

The company which can do this job has a total capability. At Hughes, this capability has many parts—a record of 15 years of scientific achievement, a working force of over 28,000, facilities covering 5.3 million square feet, vigorously applied Value Engineering and Cost Improvement programs, a fund of over 100,000 *man-years* of systems experience.

These are impressive statistics even when taken piecemeal. But they are most meaningful when seen as parts of a functional unity. For Hughes can be likened to a dynamic, *creative system* which has proved its competence and spirit of purpose many times. Examples:—*The "Missile Monitor" truck-mounted mobile command and control air defense system — 16,000 airborne fire control systems — Surveyor soft lunar landing spacecraft — 33,000 Falcon air-to-air missiles.*

The broad capabilities reflected here fully equip Hughes to assume complete management responsibility for systems assembly, check-out and integration. This competence is backed by Hughes abilities in manufacturing, assembly, operator training, operational activation, field support and maintenance.

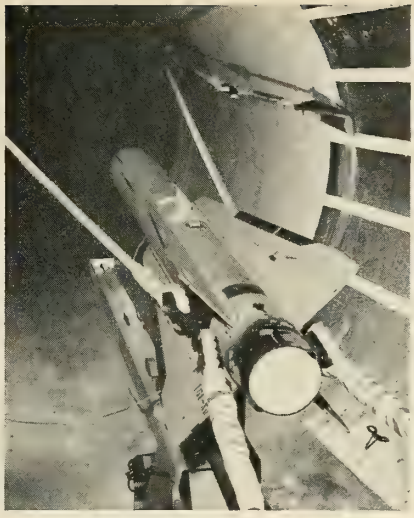
Expect more from Hughes. Hughes is ready to deliver.

Creating a new world with electronics

HUGHES

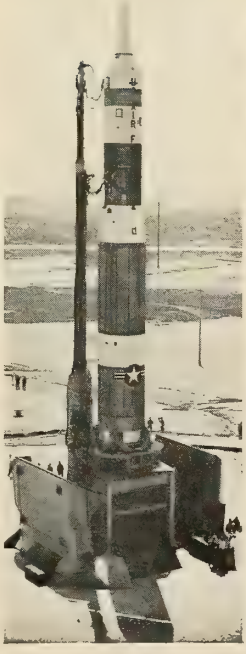
HUGHES AIRCRAFT COMPANY

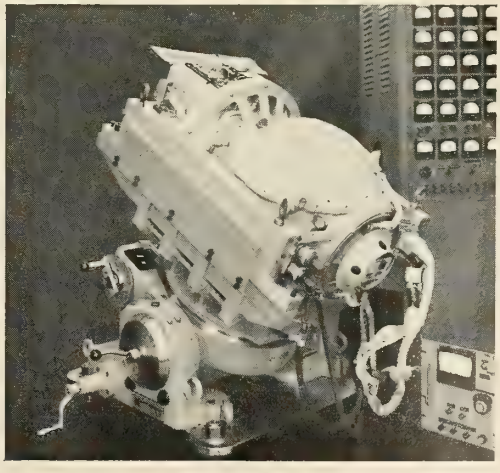
stems integration, as well as design
d development was Hughes responsi-
ity in the MA-1/F-106 program. Nine
nilar Hughes systems have preceded
d followed it—a total of 16,000 airborne
stems having been produced. Hughes
s been the sole supplier to the U.S.
Force of all-weather interceptor fire
ntrol systems for 12 years.



Propulsion facilities—Hughes has tested over 1,500 missiles in every conceivable mode of operation. The Hughes Tucson plant has extensive facilities for solid propellant and explosives storage and final missile assembly. The company maintains special propellant and propulsion capabilities to support procurement of solid fuel engines.

mand control experience—The "Mis-
Monitor" mobile electronic air defense
em performs target acquisition and mis-
directing functions for Nike Ajax, Nike
ules and Hawk batteries. At Hughes
rton, some 400 acres are devoted to
ial field test ranges for electronics sys-
and the Munsen course for full-scale
ng of instrumented vehicles under the
rugged conditions. The Environmental
ratory has one of the nation's largest
requency and shock facilities.





Guidance experience—A Polaris missile guidance unit undergoing check-out. Other Hughes work in the area includes: Polaris Submarine Fire Control Systems, special ARPAT studies, airborne tactical attack systems, inertial platforms and components, stellar tracking systems and digital computers.

d service and support experience —
nes large force of experts is permanently
ned in NATO, SEATO and the free coun-
of the world to insure that every Hughes
le and electronics system will deliver what
uld. Hughes engineers work with the U. S.
orce on the MA-1/Falcon system, with the
Navy on the Polaris, with the U. S. Army on
sile Monitor." A Hughes team is managing
Titan site activation (photo) at Mountain
e, Idaho.

Process Extrudes Smooth Beryllium

BERYLLIUM IS BEING extruded in U-shaped channels up to 39 ft. in length by the Northrop Corp., with the technical assistance of Nuclear Metals Inc.

The breakthrough in beryllium fabrication technology may lead to use of the lightweight metal in stiffening members for space structures—the long lengths would eliminate joints in an area where weight and space are at a premium.

The development stemmed from a technique perfected by Nuclear Metals during the extrusion of finned tubes for the Atomic Energy Commission. The firm used a series of copper and steel metallic lubricants around the billet.

• **Optimized dies**—Beryllium has a tendency to weld itself to die materials in extrusion presses. Since the metal is also very brittle, cracking and rattlesnaking posed problems. And excessive pressure rises during forming complicated the procedure.

In the composite lubricant method, the metallic lubricants are applied over the entire surface of the beryllium billet. Because a smooth, streamlined flow through the press is necessary, die configurations also had to be optimized.

A series of experiments resulted in a die that equally distributed the flow of beryllium through the die aperture. At a controlled temperature of 1725°F, six full-length billets 17 in. long and 3 in. wide were pushed through the Nuclear Metals press.

Six 24-ft. extrusions, with surfaces as smooth as aluminum extrusions, and entirely without cracks, resulted. There was some small tearing on two extrusions.

Dimensional variations were minor — both before and after the removal of the copper and steel lubricants. Inspection data showed a variation in thickness from front to back of 0.001 in. over the full length.

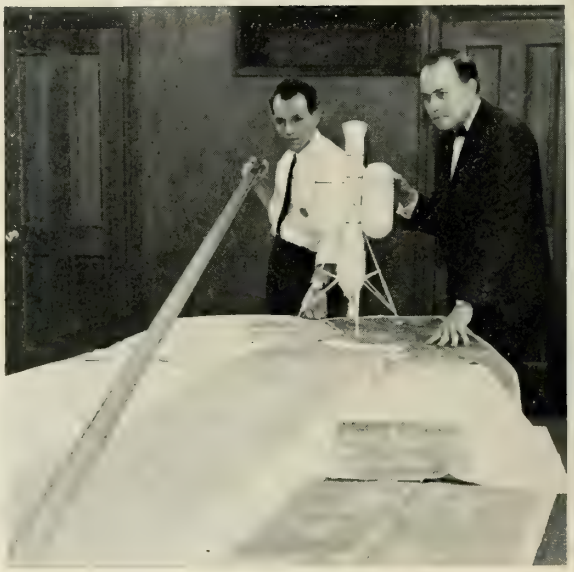
The most extensive variation of thickness that appeared on any of the extrusions was 0.005 in.—indicating the practicability of designing to tolerances of 0.003 in.

There was a considerable spread in mechanical properties, not only in elongation but also in ultimate and yield strengths. As the tensile and yield values elevated, ductility went up too.

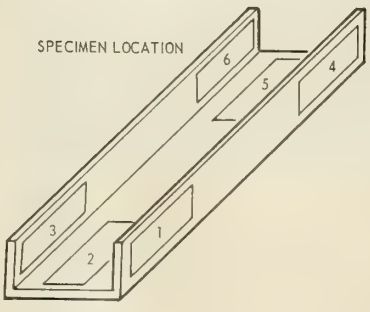
This suggested that further refinement would produce both high strength and ductile material.

After this initial success, Northrop and Nuclear Metals refined the channel-shaped extrusion down from 0.125 to 0.06 in. in thickness and extended the length to 39 ft.

The development grew out of a three-year Air Force program in which Northrop is the prime and Nuclear Metals a major subcontractor. ⁂



SMOOTH FINISH is obvious on this 24-ft., 8-lb. beryllium extrusion achieved with composite metallic lubrication.



SPECIMEN NUMBER	YIELD STRENGTH (ksi)	ULTIMATE STRENGTH (ksi)	ELONG. IN 1 IN. %	REMARKS
1	55.3	95.0	4.0	ANNEALED 1 HOUR, 750°C
2	52.9	100.7	8.5	ANNEALED 1 HOUR, 750°C
3	55.1	101.6	6.0	ANNEALED 1 HOUR, 750°C
4	64.8	81.3	3.0	AS EXTRUDED
5	57.4	84.3	3.0	AS EXTRUDED
6	59.9	62.6	0.33	AS EXTRUDED

Tensile Strength of Composite-Lubricant-Extruded Beryllium

SCIENTISTS AND ENGINEERS:

Follow-On Atlas Programs Mean New, Long-Range Opportunities.

Now operational, the Atlas weapon system stands as a unique symbol of scientific, engineering and military achievement. The design, development and testing of this reliable missile were undertakings of immense complexity.

Scientists and engineers at General Dynamics | Astronautics worked constantly at the most advanced state of the various arts involved. Boldly, they introduced and proved entirely new concepts of rocketry, and in record time they developed the Atlas.

The same depth of imagination and technical daring is now at work modifying and adapting this sophisticated machine for use as a launch vehicle for more than 100 space projects during the 1960's. Some of the exciting programs in which Atlas engineers and scientists will play important roles are Centaur, Mercury, Arents, Rover, Surveyor, Ranger, Midas, Mariner, Orbiting Geophysical Observatory and Orbiting Astronomical Observatory.

These programs reach far into the future and require the skills of highly resourceful engineers and scientists in many technical disciplines.

Atlas is the free world's first intercontinental ballistic missile; the first missile to travel more than 9,000 miles across the earth's surface; the only one to lift itself into orbit. Atlas marked the first use of swivel engines for directional control and it was the first to use airframe skin as fuel cells.

Many more "firsts" lie ahead for this reliable rocket. If you are the sort of inventive engineer or scientist who can contribute ideas and solutions to the problems surrounding the mastery of space, you and General Dynamics | Astronautics have a common interest.

You'll find most of the details on this and the following page, plus a convenient inquiry card. If the card has been removed, or if you wish to furnish or request more detailed information, write to Mr. R. M. Smith, Industrial Relations Administrator-Engineering, Dept. 130-90, General Dynamics | Astronautics, 5717 Kearny Villa Road, San Diego 12, California.

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ENGINEERING WRITERS with 2 years of college and 1 to 3 years of experience in preparation of TCTO's; operations, maintenance, and overhaul manuals.

BASE ACTIVATION: Design or liaison engineers with BE in ME or EE and experience in electrical or mechanical systems are required for liaison work at missile launching complexes, or design support work on launch control equipment, propulsion systems, automatic programming and missile checkout equipment operations. Assignments are at Lincoln, Nebraska; Altus, Oklahoma; Abilene, Texas; and Roswell, New Mexico.

FIELD TEST ENGINEERS: Electrical engineers for test and validation of complex power electrical systems using standard commercial equipment. Trouble shooting and checkout of ground electrical equipment including lighting, systems through missile-borne power distribution, fire alarm instrumentation and control. Must be thoroughly familiar with motor generators, motor control centers, AC and DC power and control circuits. Openings at Vandenburg and Edwards AFB, Calif.; Cape Canaveral, Fla.

If you desire to become part of this great team, we urge your prompt inquiry on the attached Professional Placement Inquiry.

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NORTHROP

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System Urged as Guide for Re-entry

AIL's relatively simple 'Spacescan' would be mated with 'Flarescan' aircraft landing mode for recovery

by Michael Getler

AN INFORMAL proposal is now before the Air Force to couple a new space navigation network with a "below minimums" aircraft landing system for the recovery of manned spacecraft.

The navigation system, moreover, is being advanced as a means of helping develop orbital rendezvous techniques.

Author of the proposal is Cutler-Hammer's Airborne Instruments Laboratory, Melville, L.I., N.Y., which says its new Spacescan navigation aid is similar in concept to the widely-used VOR aircraft orientation method.

The AIL system is intended to supply re-entry to recovery-area guidance to astronauts, by means of a continuing display of three-point spatial fixes obtained from scanning beams radiated from a series of ground or ship stations.

AIL maintains that Spacescan will also determine distance-to-go to the recovery area, trajectory alignment, and vehicle position relative to the re-entry corridor.

The system is relatively simple, employing only a superheterodyne Ku-band receiver and pulse-data processing circuits in the vehicle, and two mutually perpendicular horizon-to-horizon scanners at each ground location. There is no need for tracking radars or signal correlation between ground stations.

Each Spacescan ground station provides two planes of position, one across the vehicle's trajectory and the other along the flight path. Both beams are modulated with elevation angle data. The third plane and resultant position fix is obtained by correlating a third scan originating from another station within line-of-sight range of the first site.

• **3000-mile path**—AIL officials envision a network of 12 ground stations spaced about 250 miles apart as adequate for providing complete coverage for a 3000-mile re-entry path.

Each antenna structure at the ground sites consists of six antenna apertures—three radiating elevation angle data and three modulated with station, sector identity, and line-of-scan information. Each beam is energized by 0.35-microsecond pulses at 16,000 kmc. Peak transmitter power is 200 kw. Three apertures are energized at a time, radiating flat (0.5 deg.) and wide (170 deg.) beams, separated by 60 deg. in elevation angle. Three beam scans per second are broadcast to the vehicle receiver.

The Ku-band was selected primarily for its facility in avoiding black-out effects of ion sheath attenuation during early stages of atmospheric re-entry.

A receiver aboard the spacecraft decodes the elevation angle contents of each beam as it passes through the vehicle and feeds the output to a com-

Intersecting Planes of Position

puter, also aboard the craft, for determination of the vehicle's position in rectangular coordinates relative to the center of the earth. The computer also compiles information on altitude and rate of change, velocity, and the ratio of altitude change rate to velocity.

• **Final approach**—Theoretically, a glide-type vehicle would enter the "window" of the final landing pattern at about 100 miles slant range and an estimated 10-15-mile altitude. A modified version of the company's Flarescan landing system would then take over with final down-to-the-deck guidance.

Flarescan, which is aimed at extending current instrument landing system minimums to zero/zero, is now undergoing evaluation by the FAA and is reportedly a strong contender for honors in solving this major airline problem.

The final landing system envisioned by AIL would employ three scanners. The first would assist the pilot in setting up a power-off glide of between 12 and 20 deg. from initial entry into the recovery area to a point about 2 miles from touchdown. A second scanner would then set up a much more shallow glide angle, between ½ and 1 deg., which would be held to touchdown. The third scanner would be employed throughout the run-in for lateral correction.

A combined Spacescan/Flarescan network, including a dozen ground stations, would cost the Air Force about $11.5 million, according to AIL estimates. Spacescan alone would cost about $10 million.

• **Try for Apollo**—The Spacescan system was originally developed for possible employment by NASA in the *Apollo* program as either a back-up or alternate guidance system. However, the early decision to go with an MIT inertial guidance and control package, and the operational *Mercury* tracking net erased the need for additional Spacescan expense. Original cost estimates for Spacescan in *Apollo* ran to $20 million.

AIL, in marketing its system, is emphasizing its background in developing rapid-scan antennas and accurate angular measurement receivers for aircraft landing systems.

Officials also point out the following specific advantages:

—Direct and immediate on-board measurement of guidance data via a one-way propagation path.

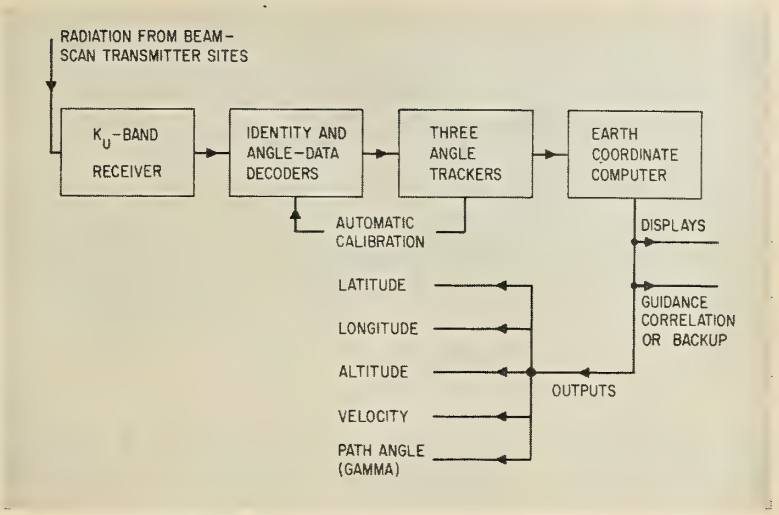
—Continuing hemispherical radio broadcast coverage throughout the reentry pattern, eliminating the need for search and lock operations.

—Independence of ground operation with no requirement for transmitting tracking data or correlating data between sites.

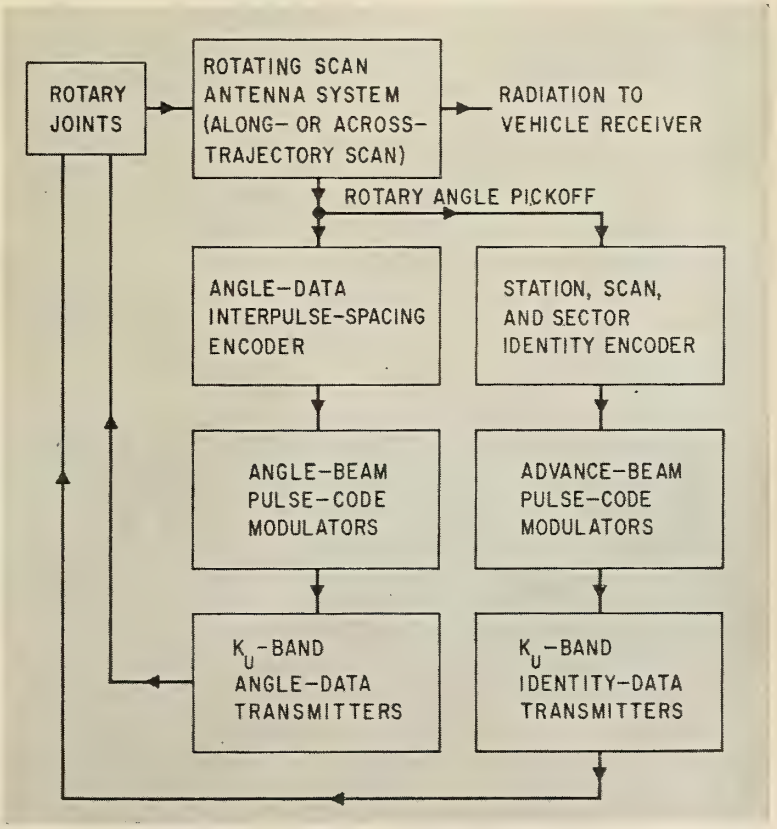
—Mobility of electronics gear; two complete K-band scanners can be moved aboard a single C-124 type transport. This could also be significant in rapid establishment of new ground sites to meet situations in which re-entry trajectory differs from the planned approach.

—Navigation service provided to any number of manned spacecraft which contain compatible receiver equipment.

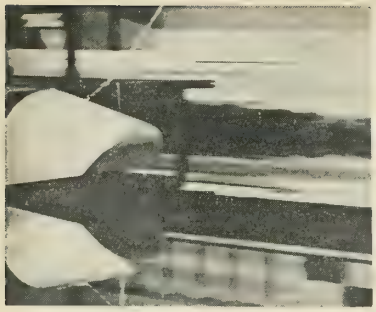
With respect to possible rendezvous applications for vehicles in 200-300 mile orbits, overall systems angular accuracy is reported to be on the order of 0.25 milliradian, or roughly equivalent to within .1 mile at a range of 400 miles from the most distant station being received. ❖

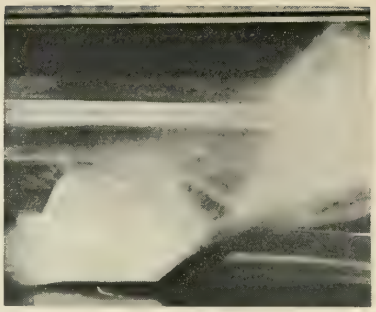


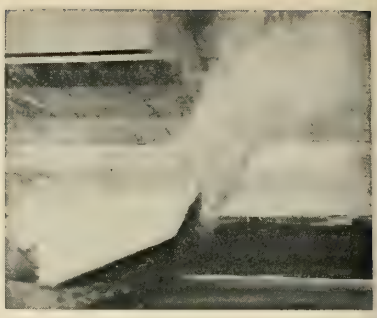
Functional Block Diagram of Spacescan Vehicle Receiver



Functioning Block Diagram of Spacescan Ground Station







WATER LANDING behavior at high speeds in a primarily horizontal velocity is not greatly changed through use of different bottom shapes. Here a flat-bottom vehicle model hits the water at a speed of 130 fps. The landing simulates ap-

space support

Varied Landing Systems for Re-entry

Dynamic models feasible for setting parameters of design; problems seen in high-speed landings

DYNAMIC MODELS are providing NASA scientists with comparative data for a number of landing-energy-dissipation systems for manned reentry vehicles.

Investigators at the Langley Research Center have been dropping and skipping various vehicle configurations into and over water, sand and concrete in an effort to understand the characteristics of such unconventional touchdowns. Three velocity regimes were studied — primarily vertical, moderate vertical and horizontal, and primarily horizontal.

L. J. Fisher, Jr., reports in a NASA Technical Note that there are several ways of dealing with the vertical energy dissipation. Some systems are more efficient, others package better; a variety of promising systems are under active investigation.

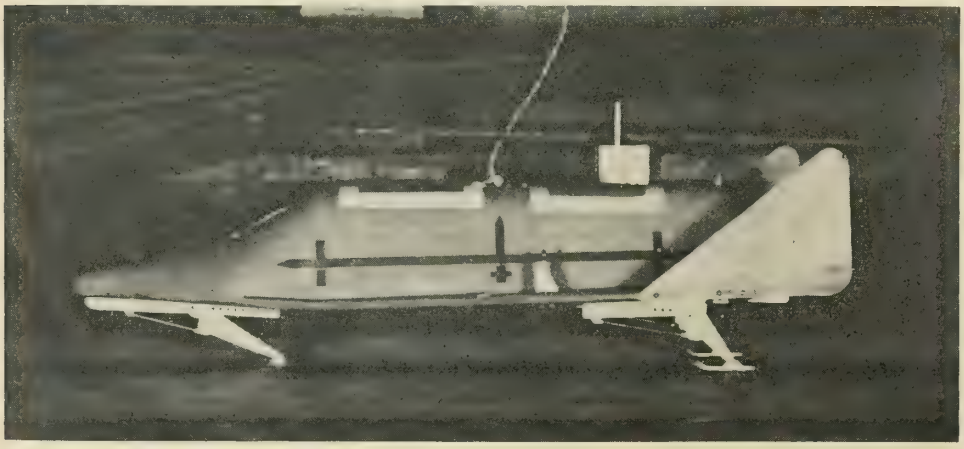
• **Fragmented landings**—In the case of vertical descent, the tests excluded side forces for comparison purposes. Energy dissipators studied included braking rockets, gas-filled bags, frangible metal tubing, aluminum honeycomb and balsa wood.

All of these systems are familiar ones, with the possible exception of the frangible metal tubes. This is a technique for working metal to its ultimate strength and through a large percent of its length.

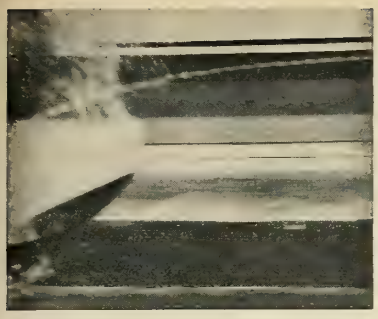
An example would be a hard aluminum-alloy tube attached to a vehicle and a die fastened to a landing skid or foot. The tube presses over the die during impact and fails in fragments.

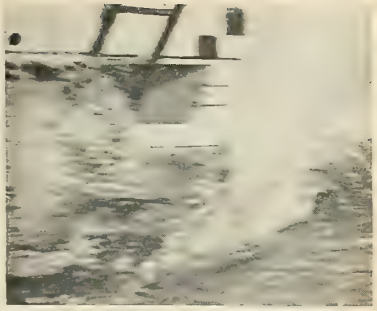
Because of structural considerations, the gas bags, frangible tubes, honeycomb and balsa wood systems are most suitable at contact velocities of the order of 20 to 40 fps. Higher speeds were not used because of suspected buckling failure.

The braking rocket is more suitable at longer strokes and higher speeds. There is a large weight difference among the several systems: the tube, honeycomb and wood systems are lightest at lower speeds but not suitable at higher speeds. Some of these



ALL-SKID gear model with strain straps landed at 185 fps. Directional stability with this gear is reported good.





proach conditions with a small, highly loaded paraglider. While the behavior of this model is much the same as that of a curved-bottom vehicle, the flat-bottom craft is susceptible to higher peak accelerations.

Vehicles Under Study at Langley

lighter methods are bulky; others, such as the gasbags, can be compactly packaged.

Water landings are very effective in dissipating the energy of vertical letdown systems. In all of the systems considered, parachutes were used to decrease the velocity to the regime favored by the particular landing means.

Models of several re-entry vehicles have been used in investigating the problems associated with moderate vertical and moderate horizontal velocities. This occurs during a parachute letdown in wind conditions or with the landing of large area paragliders.

Vertical force can be dissipated in much the same way as previously discussed. A landing skid or some similar device is required for horizontal translation, and the force must be dissipated by friction.

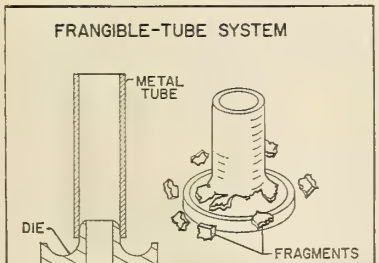
Skid shapes investigated by Fisher and his colleagues include vehicles with a flat bottom or skid with a turned-up bow, a spheroidal skid and a longitudinal skid.

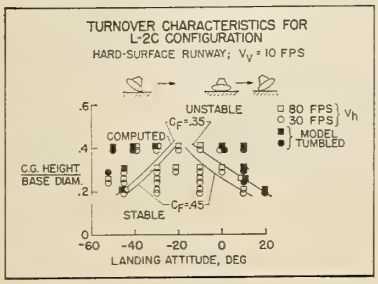
Landings were made on a smooth hard surface, on sand and water. The sand was not meant to represent any particular full-scale terrain, but rather to simulate a landing surface with penetration characteristics between those of the hard surface and water.

• **Glide descent**—The third category, covering high horizontal speed as obtained with winged or lifting bodies, is primarily a condition of long runout. This behavior, Fisher reports, is the most critical problem.

Special methods of load alleviation which are adaptable to the heat requirement of space vehicles and offer weight savings over conventional landing gear have been investigated.

Hard-surface landings with all skid-landing gear using strain-strap shock absorbers have good directional stability at speeds up to 185 fps. Water landings with a lenticular-shaped lifting body at 150 fps presented greater problems than with hard surface landings. The model frequently made second and third contact in an uncontrolled condition. Skipping was appreciably reduced when the landing speed was cut in half.





On a full-scale vehicle, the speed reduction might be effected by drogue chutes or braking rockets if adequate control could be obtained.

The water-landing behavior at high speeds of manned re-entry bodies is not greatly changed by using a different bottom shape.

The all-skid winged vehicle gear uses a strain-trap with the skids. The strap is a replacable element which fails by plastic yielding, while the skids move aft and up. There is no bounce with such gear.

Fisher says questions have been raised concerning the runout stability of such gear. It has been found that a properly designed skid is directionally stable.

In general, runout stability was satisfactory for landings at angles of roll and yaw up to 10°—the maximum investigated. The friction coefficient for the nose skid was 0.25, and for the main unit, 0.5. This difference in friction force between the front and rear skids is a major factor in the stability of the gear.

Fisher generalizes the problems by pointing to the ease of dealing with horizontal velocity — translational friction is all that is involved but runout behavior becomes a factor. Vertical velocity can also be a big factor when high flight-path angles are associated with even moderate horizontal velocities. High-speed landings are particularly difficult, especially in water. Indications are that if large horizontal velocities are involved in hard-surface landings, a selected site will be required. ⌗

TR-48 Has High Mobility, Capacity

by Charles D. LaFond

A COMPACT but still large-capacity analog computer is now being marketed for laboratory computations and simulations.

Providing up to 48 amplifiers, the new transistorized system operates on standard wall-outlets (110-120 volts) and draws only 150 watts.

Developed by Electronic Associates, Inc., of Long Branch, N.J., the PACE TR-48 occupies roughly 13 cu. ft. of space. Comparable conventional systems, designers claim, would require more than six electronic equipment racks, air conditioning, and about 10,000 watts power for normal operation.

The TR-48, EAI engineers report, is stable within a ±10% input voltage variation. In addition, they believe, the low power and system design make the unit idiot-proof against internal damage due to improper wiring of the plug boards. A visual display indicates and identifies amplifier overload.

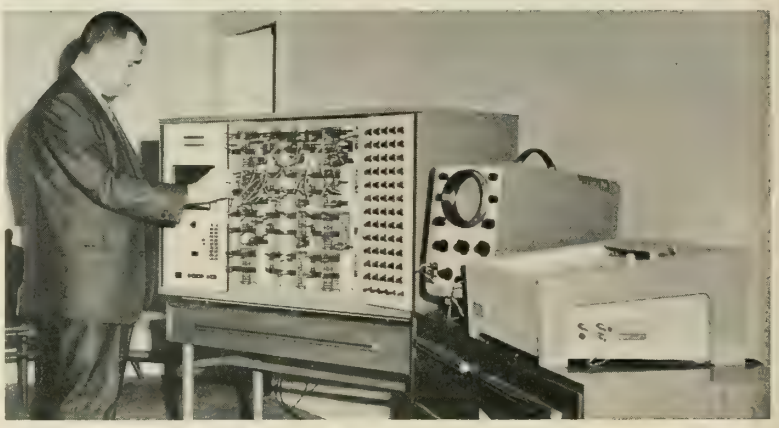
• **Happy medium** — Demonstrated for the first time at the Eastern Joint Computer Conference in Washington, D.C., last month, a complete mobile facility will consist of a rollable desk or cart with built-in oscilloscope, plotter, and the TR-48.

The real significance of the new system, developers feel, is that it is large enough to solve a wide range of engineering and scientific problems, yet small enough to be moved at will and located in the laboratory where the studies are being performed.

TR-48 is a compact 275-lb. unit housed in a single 47x20x25-in.-high cabinet. All controls, indicators and plug board are located in three distinct front locations.

On the left are the electronic digital voltmeter, a multi-range voltmeter, push-button mode control, push-button controls and readout for all amplifiers, potentiometers and input trunks. Behind the control panel are the EDVM readout chassis and a pre-patch panel motor, as well as access for the dual function generator (DFG) trays.

The EDVM provides 4-digit-plus-polarity voltage readout. It is used to obtain rapid digital readout of problem voltages and to set coefficient potentiometers.



PACE TR-48 all-transistor analog computer provides up to 48 amplifiers, operates on 115-v, and is compact enough to permit mobile use.

The center section is fronted by the removable patch board. Behind the board are all the modular plug-in computer components.

On the right are 60 potentiometers and function switches, fuses, reference regulators and reference amplifiers, power supplies and a repetitive operation drive unit.

• **Patch work** — The 24 high-gain dual amplifiers are terminated at the patch panel and are interchangable. Computing networks that consist of input and feedback resistors are matched to 0.01% accuracy.

Twelve functional areas comprise the patch panel. All similar, they terminate the operational amplifiers, integrator networks, and function generators.

Interchangeable non-linear components can be installed in any non-linear position and in most integrator network positions, EAI says.

Operational amplifiers are terminated with precision resistor networks: one 100K feedback resistor, two gain-of-one inputs, and two gain-of-ten inputs. Summing junction terminations are employed for additional inputs.

Individual integrator mode control, with bottle-plug patching from the main panel, permits their use as storage units for iterative-type calculation. Feedback capacitors in each integrator network permit the individual selection of a 10:1 integrator time scale—also by patching.

For flexibility, up to 23 other components can be installed — including multipliers, integrators, variable DFG's, fixed-function DFG's, trunks, function switches and comparators.

AC power, remote connections, recorder and trunk connections are all made at the rear of the computer.

• **Fast figuring**—Repetitive operation to real time is about 500:1.

The high-speed repetitive operation permits the TR-48 to operate either as a real-time or repetitive-computing device. A switch permits alternate operation with instantaneous change.

The capability of performing sequential or iterative calculations — wherein part of the computer is operating in compressed time and the other in real time or slower repetitive speeds —is ideal for solving many design problems. Calculations involving multi-dimensional flow and heat transfer, for example, ordinarily would require a computer many times larger, EAI says.

For complex problems requiring an expanded capability, two or more TR-48's could be slaved readily. Complete control would be possible from just one computer, and disconnection is possible at any time for simultaneous problem solution with two computers.

Depending on the basic configuration (anywhere from 20 to 48-amplifiers in the same system package) cost of the TR-48 is expected to range from $20,000 to $25,000. For comparison, the company has offered its PACE TR-10, a 10-amplifier system, for about $7000 and its 100-amplifier Model 231-R for $60,000 to $70,000. ⁂

ASTROPOWER, INC. will build a major center for advanced aerospace engineering and research projects.

The Orange County, Calif., complex ultimately may cover 50 acres and consist of 19 buildings with a total of 500,000 sq. ft. of floor space.

First phase will be construction of at 32,000-sq.-ft. building for engineering and laboratory programs and an 8000-sq.-ft. structure which initially will house administrative activities. The engineering-research facility will include a 22,000-sq.-ft. concrete structure housing Astropower Rocket Systems and Hydro Systems Div., a reproduction center and experimental machine shop.

Additional facilities will be built as required by the Douglas Aircraft Co. subsidiary.

Astropower has also formed an Electronics Products Division at Costa Mesa, Calif., for research and development in such fields as intelligence transfer systems, sensors, transducers and oceanographic instrumentation.

NORTHROP SPACE LABORATORIES has been set up by the Northrop Corp. in a move to expand the company's space research and development work.

The activity will be under the company's senior vice president-technical, Richard E. Horner, first NASA associate administrator. Headquarters will be at Hawthorne, Calif., where additional facilities are planned.

Company President Thomas V. Jones said "We are preparing to move into the field of system management on major space programs. . . . We are confident this new mobilization of our capabilities will broaden our participation in the nation's space programs."

WYLE LABORATORIES is building a testing laboratory adjacent to NASA's Marshall Space Flight Center, Huntsville, Ala.

The 13,600-sq.-ft. facility will house standards and calibration laboratories and facilities for functional and environmental testing of rocket vehicle components. Included will be high-force vibration, shock, and acceleration equipment and chambers for providing various conditions of temperature, humidity, altitude, salt spray and other environments.

The new building will be the first unit of a projected 80,000-sq.-ft., six-unit complex.

Lightweight Fast-riser

LATEST in Atlantic Research Corp.'s series of sounding rockets is the Metroc low-cost solid-fueled meteorological rocket due for flight-testing this month.

TEMCO ELECTRONICS, a Division of Temco Electronics and Missiles Co. is the new name of the electronic products activities of Ling-Temco-Vought, Inc. Headquarters are at Garland, Tex.

LINDE CO., Division of Union Carbide Corp., formed two engineering development labs at Tonawanda, N.Y., to conduct technical programs for the company's Gas Products and Cryogenic Products Dept.

SIERRA METALS CORP., a subsidiary of Martin Marietta Corp., will establish a Metals Technology Lab near Portland, Ore., to develop high-temperature materials and processes pertaining to space exploration, defense and industry.

The lab is under the direction of R. H. Thielmann, former chairman of the metallurgical department at Stanford Research Institute. It will concentrate its research activities on development of new and improved high-temperature alloys and metallurgical processes.

VITRO CORP. OF AMERICA and A. O. Smith Corp. have merged, giving Vitro added manufacturing facilities for its research and development operations.

Corporate headquarters for Vitro-Smith Corp. will be in New York. President is Norman Spector, Vitro vice president. The new company is expected to concentrate on space, nuclear, cryogenic and other advanced technical projects for the government.

In the defense field, A. O. Smith has been producing nuclear components and missile chambers for the Department of Defense. It also builds high-pressure air accumulators, air heaters, coolers and other equipment for NASA.

WARNECKE ELECTRON TUBES, INC. has been formed in Chicago to provide research, development and manufacturing facilities for high-power microwave tubes and other vacuum devices for military and commercial markets. It will be jointly owned by The Hallicrafters Co. and Compagnie Generale de Télégraphie Sans Fil (CSF) of Paris. The company will break ground in February for a plant.

Financial Reports

COMPANY	PERIOD	INCOME		EARNINGS	
		1961	1960	1961	1960
Bendix Corp.	Year, Sept. 30	$752,800,000	$787,000,000	$23,968,664	$26,188,471
Collins Radio Co.	3 Mo., Oct. 31	44,961,118	53,341,464	201,627	1,484,958
Data Control Systems, Inc.	Year, Sept. 30	3,790,226	3,381,417	162,336	48,932
Gulton Industries	9 Mo., Nov. 30	17,242,000	9,319,000	706,000	564,000
Microwave Associates, Inc.	Year, Sept. 30	10,709,500	8,691,500	756,000	593,500
Nytronics, Inc.	4 Mo., Dec. 1	1,053,584	539,978	—	—
Perkin-Elmer Corp.	3 Mo., Oct. 31	5,742,000	5,391,000	232,408	138,710
Technical Operations, Inc.	Year, Sept. 30	5,095,500	4,285,000	208,100	119,200
Wayne George Corp.	Year, Sept. 30	1,528,613	1,001,206	131,347	57,771
Yardney Electric Corp.	6 Mo., Oct. 31	5,795,954	4,797,554	325,518	281,131

(Continued from page 17)

bers of asteroids plotted against their period shows conspicuous gaps where the periods are simple fractions of Jupiter's orbital period.

The choice of stable orbits for the space probes around the outer planets should be made with this factor in mind. An improperly chosen orbit will require more correction maneuvers and use up its fuel faster.

• **Titan**—The sixth moon of Saturn, Titan, would be a respectable planet if it had an orbit of its own, as it is larger than Mercury. It is massive enough, in fact, to have a substantial methane atmosphere.

There are other interesting properties, such as its orange color—unlike any of the other moons of Saturn or any of the planets with methane atmospheres. The color is presumed to be due to the action of the atmosphere on the surface, just as oxidation is assumed to be the cause of the reddish color of Mars.

It has been proposed that Titan be used as a refueling base for the exploration of the outer planets. Its low gravity and methane atmosphere would permit atmospheric drag landings and the low escape velocity would allow a considerable amount of fuel to be lifted.

• **Methane as a fuel** — Methane (CH_4) is a good rocket fuel, and its availability on a body with a low escape velocity is quite fortuitous. In a chemical rocket, the performance of methane is midway between present-day fuels and liquid hydrogen. In combination with oxygen its specific impulse is 263 sec. Because its boiling point is 50°C below that of ozone, yet still above the ozone freezing point, methane is particularly useful in combination with ozone.

Since there is no known ozone or oxygen on Titan, its use as a refueling base for chemical rockets is of doubtful value since it would be necessary to carry the oxidizer half of the combination.

Considerable thought, however, should be given to the use of Titan methane in nuclear rockets. It would not be as good as pure hydrogen, because the rocket would have to cope with the heavy carbon atom along the four hydrogen atoms, but it is free and available provided you don't mind contaminants such as ammonia.

The design and development of a large nuclear rocket engine capable of efficient, long-duration operation using impure methane could be the key to the commercial utilization of the solar system.

One thousand tons of Titan methane in orbit around the earth may well be cheaper than an equivalent amount of Texas methane. (Although delivery dates are longer.)

• **The trip to Saturn** — Although minimum energy interplanetary orbits, needing only the attainment of escape velocity from earth, could conceivably be used for journeys through the solar system, they require almost prohibitively long transit times. For Jupiter alone, a round trip would take six years; for the planets beyond Saturn, the times become comparable to a human lifetime.

We must adjust to the fact that we cannot "coast" to the outer planets, we will have to "drive" there, applying power all the way. If we build the power sources — and especially if refueling is possible — then direct routes at high speeds become more practical.

• **Powerplants** —The key to the exploration of the solar system is the development of very large, lightweight power sources. The actual method of applying the power to the reaction mass, whether it is an ion drive or direct nuclear rocket is of relatively minor importance.

The practical minimum, even for unmanned probes, is in the megawatt region. And for manned expeditions to Saturn and beyond, we will need tens and hundreds of megawatts with specific powers of 1 to 10 kw/kg 1 kw/kg=1 Mw/Ton). Fortunately, the greater the power output, the larger the specific power.

To show what is necessary for a trip to Saturn, and how the availability of a large power source makes a considerable difference in the transit time, let us look at some figures from a recent aeronautical journal. Starting from a 300-mile orbit:

Transit Times and Payloads to Saturn

Powerplant (Megawatts)	Specific Power (Mw/Ton)	Transit Time (Days)	Payload (lb.)
1	0.2	730	12,500
		970	21,000
10	2	250	4,000
		550	26,000

Larger powerplants will cut these transit times even further.

• **Solar particle radiation** — Before space travel became a reality, it was thought that the major space hazard would be meteors. Many methods have been proposed to avoid this practically non-existent hazard; they range from the practical "Whipple Meteor Bumper" through the unfeasible meteor radar (which is a practical impossibility due to the slowness of the speed of light) to the imaginary invention of the science fiction writers, the "force field meteor screen."

But we have found with our instrumented space probes that the real danger is not from meteor strikes, which are very rare, but from solar particles, either trapped in the Van Allen belts or shot out by solar flares. This is a very real problem, and unless a solution is found, manned flight to any of the planets will be a risky business.

The astrophysicists are now learning to predict the flares, but it is doubtful that they can predict more than a few days ahead. This will allow them to cancel moon flights and chart flare free periods for a dash to the moon, but the transit times needed for interplanetary travel are much longer and it would be next to impossible to avoid being radiated by a solar flare.

The solar particles are high-energy protons which are very difficult to stop.

Saturn and Its Major Moon

		SATURN	TITAN
Orbital Radius	(km)	1.43×10^9	1.2×10^6
Period	(days)	10759	16
Rotation	(days)	.42	16
Radius	(km)	60,000	2500
Mass	(kg)	5.7×10^{26}	1.4×10^{23}
Density	(gm/cm^3)	0.687	2.1
Surface Gravity	(cm/sec^2)	1120	146
Escape Velocity	(km/sec)	37	3 + 8.5
Orbital Velocity	(km/sec)	26	2

The very thick lead shielding which would be required for this is out of the question for today's rocket technology.

Even though the protons are emitted from the sun, one cannot use a shadow shield. The protons seem to be mixed up with a magnetic "bottle" extending out from the sun. Shortly after the leading edge of the flare passes by, it is found that the high-energy protons are coming from all directions.

• **Force fields** — But some new scientific developments, coupled with some old tricks used in high-energy particle research, may contain the solution.

Although we have no idea how we could make a "force field meteor screen" that will stop uncharged solid bodies, we do know how to construct a force field that will ward off ionized solar protons. It is nothing more than a magnetic field.

Magnetic fields are used by atom smashers to deflect ionized particles and the earth's magnetic field deflects a large portion of the particles sent out by the sun. A magnetic field of a few thousand gauss will turn a high-energy particle completely around in a few meters.

Until recently, it was not possible to maintain high magnetic fields without expending a considerable amount of power. The power was necessary to take care of the resistive losses in the electromagnetic coils. But it has been found that magnetic field of 100,000 gauss can be created using a special superconducting Tin-Niobium alloy.

Since superconductors have zero resistance, it does not require power to sustain the magnetic field once it is set up. Because of this energy-conserving property — and the need for even stronger magnetic fields in nuclear physics—a great deal of work is being done today on superconductors and their application.

The ultimate goal in nuclear physics is to obtain many hundreds of thousands of gauss over large bubble chambers 8 or more feet in diameter. If these technical problems can be solved, then it is not too much further to the construction of a magnetic shield for a space vehicle. Keeping the superconductor near absolute zero will not be a difficult problem. The vacuum of outer space is the best insulator there is, and closed-cycle 4° K refrigerators weighing less than 20 lbs. are available right now.

A more difficult problem will be learning to live and operate electronic devices in such high fields, or designing the coils to eliminate the field in the vehicle cabin. ⌗

Increased technical responsibilities in the field of range measurements have required the creation of new positions at the Lincoln Laboratory. We invite inquiries from senior members of the scientific community interested in participating with us in solving problems of the greatest urgency in the defense of the nation.

RADIO PHYSICS and ASTRONOMY

RE-ENTRY PHYSICS

PENETRATION AIDS DEVELOPMENT

TARGET IDENTIFICATION RESEARCH

SYSTEMS:
Space Surveillance
Strategic Communications
Integrated Data Networks

NEW RADAR TECHNIQUES

SYSTEM ANALYSIS

COMMUNICATIONS:
Techniques • Psychology • Theory

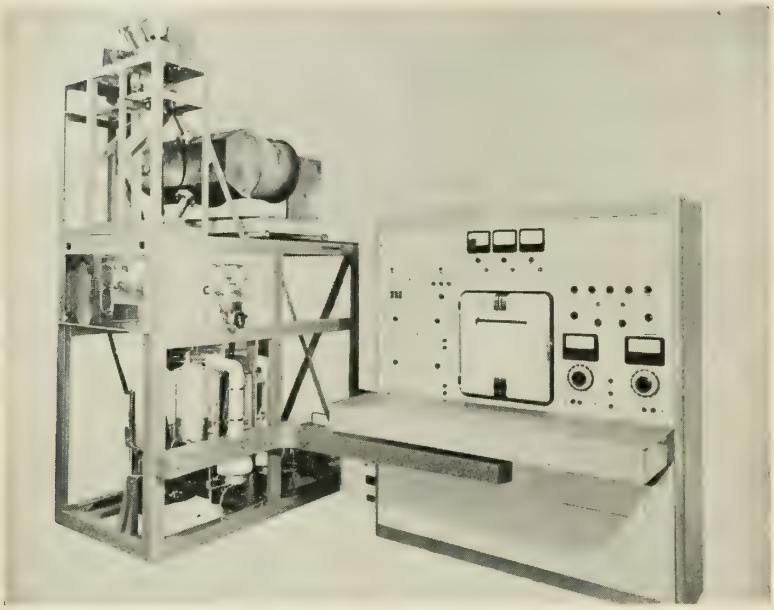
INFORMATION PROCESSING

SOLID STATE
Physics, Chemistry, and Metallurgy

• *A more complete description of the Laboratory's work will be sent to you upon request.*

All qualified applicants will receive consideration for employment without regard to race, creed, color or national origin.

Research and Development
LINCOLN LABORATORY
Massachusetts Institute of Technology
BOX 26
LEXINGTON 73, MASSACHUSETTS



New Product of the Week: Solids Mass Spectrometer

A FIRST ORDER, angular-focusing mass spectrometer with a 60° sector magnetic field on a 12-in. radius has been introduced by the Analytical & Control Division of Consolidated Electrodynamics Corp.

Designed for the analysis of solids in a wide range of research and process applications, the Type 21-703 Mass Spectrometer is available with either a Knudsen Effusion Cell or a thermal ionization source. The Knudsen or crucible source is used to study high-temperature reactions in solids and for analysis of solids which are non-conductors. Vaporization rates and equilibrium vapor pressures are studied by measuring the pressures of gaseous species in equilibrium with the condensed phase.

With a Knudsen cell, the mass spectrometer identifies molecular species and suppresses competing processes through use of a highly collimated molecular beam which crosses the ionization chamber perpendicular to the ionizing electron beam.

Circle No. 225 on Subscriber Service Card

Data Acquisition System

A 10-channel Analog-to-Pulse Duration Instrumentation System for precision applications in process control through direct digital conversion of analog input from d-c sensing devices is available from Genisco, Inc. It provides inherent high accuracy of 1 part in 1000 full scale, regardless of range. Solid-state modular construction makes the APD System rugged and readily adaptable by gating techniques and logic circuitry to actuate controls or alarms for any selected point or bracket within the unit's range.

Circle No. 226 on Subscriber Service Card

Bolometer Mount Calibration

The Weinschel Engineering Company of Kensington, Md., has available a complete calibration service for coaxial or Thermistor Mounts up to 4 kmc.

The service is limited, at present, to those mounts having a d-c resistance of 200 ohms for bias currents of from 4 to 13 milliamperes.

Mounts to be calibrated must be mechanically stable with an input VSWR in a coaxial 50 ohm system of less than 1.30. Tuning elements, if any, must be fixed since they will be sealed prior to calibration so that they cannot be moved. Accuracy of the determination of the "calibration factor" is ±2% or better.

Circle No. 227 on Subscriber Service Card

Traveling Wave Tube

General Electric Company is marketing an X-band traveling-wave tube amplifier with a maximum noise figure of less than 8 db.

The ZM-3123 is a lightweight, permanent-magnet-focused tube designed for operation in the 8.5-9.6 kilomegacycle frequency range. It features a nominal power output of 5 milliwatts and a minimum small signal gain of 25 db.

Circle No. 228 on Subscriber Service Card

Tilt Tables

The 201 Static Tilt Tables available in two models from Micro Gee Products, Inc., offer a convenient, accurate method for furnishing incremental angular inputs to accelerometers, gyros, and similar devices.

Both instruments feature a large engraved vernier scale on the outer axis providing setting accuracies to 0.05° throughout the 360° range. The 7-in.-

diameter platform itself can also be rotated through 360° and is indexed with a locking pin at 45° intervals. Initial leveling of the table is accomplished by a three-point leveling system and a spirit level aligned with the table surface.

Circle No. 229 on Subscriber Service Card

Pulse Generator

A compact and versatile pulse generator, Type 1217-B, having a wide range of pulse durations and repetition rates, is available from the General Radio Co.

Pulses are either generated internally at pulse repetition rates from 2.5 to

500,000 cps, a frequency range comparable to that of most general-purpose oscilloscopes, or triggered by external signals from dc to 1 mc. Main output pulses are simultaneous positive and negative 40-ma pulses, dc-coupled. Amplitude is adjustable, to a maximum of 40 v into 1000 ohms.

Duration of the main pulse is adjustable from 0.1 usec to 1 sec, in seven decade ranges. The rise time of the main pulse depends on the termination used.

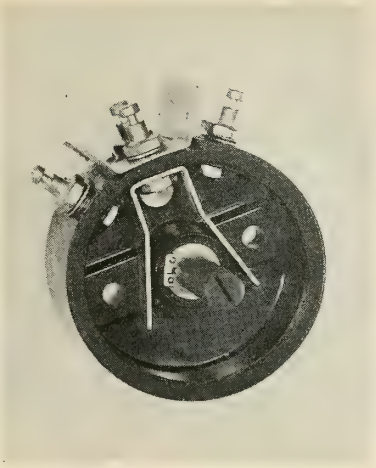
Circle No. 230 on Subscriber Service Card

Ultrasonic Degreasing System

A 500-watt ultrasonic degreaser for production systems is available from Ultrasonic Power Division of Branson Instruments, Inc. Designed for use with Freon-TF for particularly critical cleaning applications, or with conventional solvents, the LAC-100 degreaser is capable of processing up to 1500 lbs. of steel per hour.

The unit consists of a boiling sump, a heated transducerized tank for ultrasonic cleaning, and a generator to supply the "ultrasonic elbow grease". A recirculating pump and filter, water separator, and a solenoid-controlled spray rinse are also provided.

Circle No. 231 on Subscriber Service Card



Variable Delay Line

A variable delay line, Type 301-S104, with a total range of from 0 to 25 nonoseconds ±10%, is available from General Radio Co. In addition to the narrow-range feature, the line affords a resolution of 0.06 nsec and a pulse rise time of approximately 2.4 nsec at maximum delay. Precious metal wire is used in a distributed winding to assure reliable contact, and shielding is incorporated to minimize capacitive coupling between the input and output terminals. Characteristic impedance of the delay line is 200 ohms ±20%, and the dc resistance is 5.5 ohms ±20%.

Circle No. 232 on Subscriber Service Card

Telemetering Filters

A line of miniature telemetering filters featuring high adjacent channel rejection and low insertion loss is being produced by CircuitDyne Corp., a subsidiary of Telonic Industries, Inc.

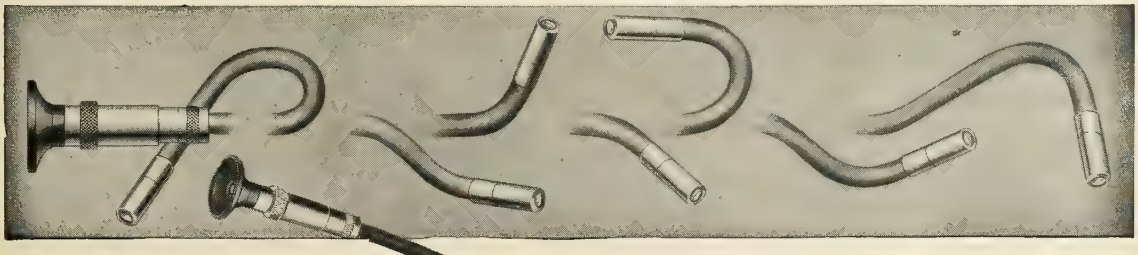
Available with any center frequency from 400 cps through 70,000 cps, the new filters provide isolation of telemetry channels in a common circuit, with a minimum of 30 db rejection of adjacent channels. The pass band itself is held to within ±2 db.

Circle No. 233 on Subscriber Service Card

Multiple Capacitor

Gulton Industries, Inc. is marketing a Faradyne Mylar capacitor. The multiple capacitor unit is hermetically sealed with capacitance values of 1 mf - 0.1 mf - 0.01 mf and 0.001 mf within one single unit. The tolerance on these values within one unit is ±0.25%. Other units have been manufactured with a different combination of capacitance values, such as 0.5 mf - 0.05 mf - 0.005 mf and 0.00046 mf in a hermetically sealed can.

Circle No. 234 on Subscriber Service Card



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names in the news

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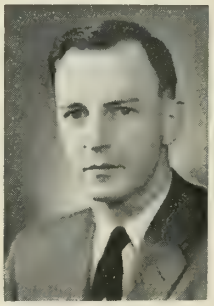
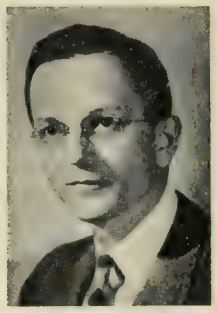

SHAFER

JACQUISH

COGNE


MACLEISH

Harrison A. Storms, Jr.: Recently named president of North American's new Space and Information Systems Division which won the contract for the *Apollo* spacecraft, has been given the American Rocket Society's James H. Wyld Award for "his outstanding leadership and distinguished engineering and administrative contributions to the *X-15* program," and the Richards Memorial Medal of the American Society of Mechanical Engineers, also for his part in planning the *X-15*. Storms has been with North American since 1941.

R. I. Allen: Elected executive vice president of Hills-McCanna Company, Carpentersville, Ill. He has, since joining the company in 1957, served as general manager of the foundry division, general sales manager, and vice president in charge of sales, engineering and foundry operations. In Allen's new position, his duties have been enlarged so that he will have overall responsibility for administration of regular company operations.

Don Margerum: In his new post as Director of the Systems Laboratory Division of Electronic Specialty Co., will direct research and development activities as well as system integration. He was previously chief engineer of the company's Radiating Systems Division. Earlier, he was director of electronics for the Systems Laboratory Corporation, which was acquired by Electronic Specialty Co. in 1959, and was a senior research engineer with Stanford Research Institute.

S. L. McDonough: As manager of the new weapons applications department of the Univac Military Department, St. Paul, Minn., has been given the responsibility of aerospace computer developments and their application to military weapon systems. He was formerly with McDonnell Aircraft Corp. where he pioneered the design of lightweight digital computers for guidance and control of missiles and space vehicles. Prior to holding that position, he was with the Cornell Aeronautical Laboratories for 11 years.

Thomas H. Miller: Has joined Frederick Research Corp. as director of engineering. Miller has held positions with Vitro Laboratories and International Electronics Engineering, Inc.

Guy C. Shafer: For the past two years vice president and general manager of New England Aircraft Products Co. of Plainville, Conn., has been named vice president-planning at Chandler Evans Corp., West Hartford, Conn. For 13 years before joining New England Aircraft, Shafer was associated with General Electric Co., first at its Jet Engine department at Evendale, Ohio, and more recently as general manager of its Small Aircraft Engine department at Lynn, Mass.

William D. Myers: Formerly senior project engineer for Raytheon-Spencer Laboratories, has been named general manager of Resistron Laboratories, Santa Monica, Calif.

Herman L. Weiss: General manager of General Electrics Lamp Division, has been elected vice president of the parent company. As vice president and general manager of the Lamp Division, he is responsible for six operating departments. He has been with the company since 1939.

William W. Jacquish: Appointed senior sales engineer for research and development programs in the Martin Marietta Electronic Systems and Products Division. Jacquish formerly worked for Philco as project engineer for a portion of the *Sidewinder* missile project, and later was manager of advanced engineering in the Hoffman Electronics Corp.

Harry M. Miller: Ohio utility executive, has been elected chairman of the board of Battelle Memorial Institute. President and board chairman of the Columbus and Southern Ohio Electric Company since 1956, Miller is also a trustee of the Power Reactor Development Company. **Dr. John A. Wheeler,** Princeton University physicist noted for his work in the field of nuclear energy, was named first vice chairman. Retiring chairman **Dr. Zay Jeffries,** former vice president of General Electric Company, remains on the board as honorary chairman. Other members of the board are: **Dr. Roger Adams,** internationally known chemist and educator; **Gerald B. Fenton** and **Harry M. Runkle,** both Columbus, Ohio, businessmen. Serving as associate trustees are **Dr. Arthur C. Cope,** head of the Department of Chemistry at Massachusetts Institute of Technology and current president of the American Chemical Society, and **Dr. John Robinson Pierce,** director of research in communication principles at Bell Telephone Laboratories and originator of the *Echo I* satellite concept.

James A. Nickerson: Formerly vice president in charge of sales, has been elected executive vice president of Hill Electronics, Inc. Nickerson, with the company since 1958, will coordinate the planned expansion in the fields of instrumentation and systems with present operations. Prior to his present position, he was associated with the Titeflex Corp. and with the Patchogue Plymouth Corp.

Robert Cogne: Succeeds **Dr. Ernst M. Huttrer,** who has resigned, as executive vice president of Intercontinental Electronics Corp., Westbury, L. I., N. Y. Cogne transferred to INTEC from CSF-Compagnie Génerale de Télégraphie Sans Fil of Paris in June. CSF is the majority stockholder in INTEC and was one of the founding companies. Cogne held many engineering and administrative posts during his 12 years with CSF.

Dr. Kenneth G. Macleish: Elected a vice president of the Perkin-Elmer Corp. and named director of engineering of its Electro-Optical division. Prior to his present position, Macleish was with Eastman Kodak Co., where most recently he was assistant director of research and engineering in the Apparatus and Optical division.

William C. House and **Dr. Ernest R. Roberts:** Elected vice president-Nuclear Rocket Systems and vice president, respectively, of Aerojet-General Corporation. House, who has been with Aerojet since 1949, is at present director of *Nerva* Operations. Roberts joined Aerojet in 1947 and has contributed significantly to the growth of solid-fuel rockets, especially in the development of segmented large rockets as super boosters.

contracts

AIR FORCE

$67,800,000—**Peter Kiewit and Sons Co.,** Omaha for construction of *Minuteman* launch facilities near Minot AFB, N.D.

$35,000,000—**Air Products and Chemicals, Inc.,** Allentown, Pa., for liquid hydrogen over a five-year period.

$18,259,999—**The Bendix Corp.,** Detroit, for central air data computer systems and spare parts and support equipment, and for transportable tropospheric radio sets for use in world-wide communications systems. (two contracts).

$11,100,000—**Aerojet General Corp.,** Sacramento, Calif., for stage two of *Minuteman* solid-propellant rocket motors and related equipment, and for research and development work on the *Titan* weapon system. (two contracts)

$9,811,000—**Martin Marietta,** Denver, for installation and checkout of ground equipment, and for fabrication and installation of ground equipment for the *Titan II* weapon system.

$7,940,433—**Anaconda Wire and Cable Co.,** Hastings-on-Hudson, N.Y., for intersite communications cable for missile sites at Ellsworth AFB, N.D.

$6,211,772—**General Electric Co.,** for installations of precision missile trajectory measurement system and support equipment with work to be done at Eleuthera Island.

$5,000,000—**Rocketdyne division, North American Aviation, Inc.,** for MA-3 rocket engine production, work to be performed at Neosho, Mo., McGregor, Tex. Canoga Park, Calif., and Santa Susana, Calif.

$4,400,000—**Radio Corporation of America,** Burlington, Mass., for production of final-stage vehicles and provision of services to support a satellite program.

$4,000,000—**General Electric Co.,** for classified work on space vehicles; to be performed at Philadelphia.

$2,200,000—**The Boeing Co.,** Seattle, for assembly and checkout of *Minuteman* Wing II.

$1,848,688—**The Boeing Co.,** Seattle, for spare parts in support of the *Bomarc B* (supplemental contract).

$1,650,000—**Minneapolis-Honeywell Regulator Co.,** Minneapolis, for study of aerospace technological experiments.

$1,600,000—**Hughes Aircraft Co.,** Culver City, Calif., for weapon system evaluator missile, spare parts and data for *GAR-3A* and *GAR-1D* (one contract and one letter contract).

$1,220,450—**Solar Aircraft Co.,** San Diego, Calif., for power units of a gas turbine engine.

$580,500—**General Electric Company,** Philadelphia, for research, development, testing, fabrication and related work for the *Nike-Zeus* target vehicle.

$107,602—**Hoffman Electronics Corp., Military Products Division,** Los Angeles, for engineering services and spare part support for electronic reconnaissance systems.

ARMY

$138,936,717—**The Martin Co.,** Orlando, Fla., for research and development and for production of the *Pershing* weapon system (two contracts).

$25,378,198—**Raytheon Co.,** Lexington, Mass., for electronic tubes, engineering services, radar illuminators and field maintenance test equipment shops for *Hawk* missile system.

$13,134,800 — **Aircraft Armaments, Inc.,** Cockeysville, Md., for updating and modifying training devices used with the *Nike-Hercules* system.

$13,070,725—**Hercules Powder Co.,** Wilmington, Del., for production of missile propellants at the Radford, Va., Ordnance Plant.

$12,376,800—**Sylvania Electric Products, Inc.,** Waltham, Mass., **Bell Telephone Co.,** Whippany, N.J., and **General Electric Corp.,** Syracuse, N.Y., for additional research and development of advanced radar for the *Nike-Zeus* antimissile missile.

$11,607,970—**Eclipse Pioneer division, The Bendix Corp.,** Teterboro, N.J., for production of *Pershing* missile parts and engineering services.

$2,071,000—**Western Electric Co.,** for work on the *Nike-Hercules* improved engineering service, with work to be performed at Burlington, N.C., **General Electric** plant in Syracuse, N.Y., and at the **Douglas Aircraft** plant in Charlotte, N.C.

$7,261,776 — **General Dynamics Corp.,** San Diego, Calif., for production improvement of ground support equipment for *Atlas* missiles.

$6,159,162—**Western Electric Co.,** New York, for technical manuals and for improved guidance system and components for *Nike-Hercules* (two contracts).

$5,804,435—**Douglas Aircraft Corp.,** Charlotte Ordnance Missile Plant, Charlotte, N.C., for work on *Nike-Hercules* missile components.

$5,010,070 — **Aerojet-General Corp.,** Nimbus, Calif., for loading, assembling, and packaging of *Hawk* air defense guided missile motors.

$3,600,000—**Sperry Utah Co.,** Salt Lake City, a division of Sperry Rand Corp., for industrial engineering services on the *Sergeant* guided missile system.

$2,230,274 — **Nortronics division, Northrop Corp.,** Anaheim, Calif., for 2387 units of *Hawk* missile wiring assemblies.

$2,211,920—**Raytheon Co.,** Lexington, Mass., for continued engineering services on the *Hawk* missile system.

MISCELLANEOUS

$40,000,000—From **North American Aviation, Inc., Space and Information Systems Division,** to **Collins Radio Co.,** Cedar Rapids, Iowa, for the telecommunications system for the *Apollo* spacecraft.

$30,000,000—**From North American Aviation, Inc., Space and Information Systems Division,** to **Minneapolis-Honeywell Regulator Co.,** Minneapolis, for the stabilization and control systems for the *Apollo* spacecraft.

$10,000,000—From **North American Aviation, Inc., Space and Information Systems Division to AiResearch Manufacturing Co.,** Los Angeles, for environmental control for the *Apollo* spacecraft.

$1,000,000 — From **North American Aviation, Inc., Space and Information Systems Division to Radioplane Division of Northrop Corp.,** Van Nuys, Calif., for parachute landing system for the *Apollo* spacecraft.

NAVY

$1,374,000 — **Martin Co.,** Orlando, Fla., for *Bullpup* missiles for the Air Force.

$1,192,220 — **Aerojet-General Corp.,** Sacramento, Calif., for research and development of advanced *Polaris* propellant.

$500,000—**Elgin National Watch Co.,** Elgin, Ill., for an electronic communications system.

$400,000—**Westinghouse Electric Co.,** Washington, D.C., for one Mk 17 launcher system trainer for Dam Neck, Va., work to be performed at Sunnyvale, Calif.

$360,242—**Douglas Aircraft Co.,** Santa Monica, Calif., for furnishing and installing one prototype *Bullpup B* in government-owned airplane.

$277,627—**General Time Corp., Westclox division,** LaSalle, Ill., for safety and arming device for *Sidewinder 1A* guided missile.

NASA

$2,118,600—**The Bendix Corp.,** Detroit, for construction of the stable platform using air-bearing gyros for the inertial guidance system of the *Saturn* space vehicle.

$1,000,000—**Kollsman Instrument Corp.,** subsidiary of **Standard Kollsman Industries,** New York, for instruments for the *Orbiting Astronomical Observatory.*

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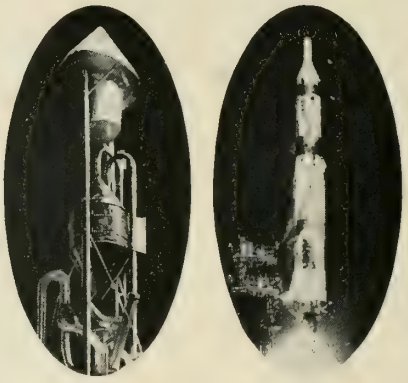

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when and where

JANUARY

Automotive Engineering Congress and Exposition, sponsored by Automotive Engineers, Inc., Cobo Hall, Detroit, Jan. 8-12.

8th Annual Symposium on Reliability and Quality Control, Statler-Hilton Hotel, Washington, D.C., Jan. 9-11.

1962 Business Outlook Conference, sponsored by the Los Angeles Chamber of Commerce, Biltmore Hotel, Jan. 10.

30th Annual Meeting, Institute of the Aerospace Sciences, Hotel Astor, New York City, Jan. 22-24.

National Plant Engineering and Maintenance Show and Conference, Convention Hall, Philadelphia, Jan. 22-25.

Solid Propellant Rocket Conference, ARS, Baylor University, Waco, Tex., Jan. 24-26.

American Society of Mechanical Engineers, 2nd Symposium on Thermo-Physical Properties, Princeton, N.J., Jan. 24-26.

FEBRUARY

Western Electronic Week and Pacific Electronic Trade Show, Palm Springs, and Los Angeles, Feb. 3-11.

Winter Convention on Military Electronics, IRE, Ambassador Hotel, Los Angeles, Feb. 7-9.

International Solid State Circuits Conference, Philadelphia, Feb. 14-16.

Tracking and Command of Aerospace Vehicles, Institute of the Aerospace Sciences, Gunter Hotel, San Francisco, Feb. 19-21.

Third Annual Symposium on Nondestructive Testing of Aircraft and Missile Components (Southwest Research Institute), Gunter Hotel, San Antonio, Tex., Feb. 27-Mar. 1.

MARCH

Institute of Radio Engineers, 8th Scintillation and Semiconductor Counter Symposium, Washington, D.C., Mar. 1-3.

Fifth Annual Technical Conference, Society of Vacuum Coaters, Sheraton-Cleveland Hotel, Cleveland, Mar. 6-7.

Armed Forces Communications and Electronics Association, Cape Canaveral Chapter, symposium, Cocoa Beach, Fla., Mar. 6-8.

Flight Propulsion Meeting (classified), Institute of the Aerospace Sciences, Cleveland, Mar. 8-9.

1962 Symposium on Packaging of Chemical Products, sponsored by Manufacturing Chemists' Association, Inc., St. Louis, Mar. 13-14.

Electrical Propulsion Conference, ARC, Hotel Claremont, Berkeley, Calif., Mar. 14-16.

Goddard National Space Conference, sponsored by the National Rocket Club, Sheraton Park Hotel, Washington, D.C., Mar. 14-16. (Goddard Memorial Dinner on Mar. 16.)

Third Symposium on Engineering Aspects of Magnetohydrodynamics, sponsored by University of Rochester, AIEE, IRE, IAS, University of Rochester, N.Y., Mar. 28-29.

APRIL

American Rocket Society, Launch Vehicles: Structures and Materials Conference, Ramada Inn, Phoenix, Ariz., April 3-5.

Thirteenth Annual Advanced Statistical Quality Control Institute, University of Connecticut, Storrs, April 8-20.

Institute of Environmental Sciences, Annual Technical Meeting and Equipment Exposition, Sheraton Towers Hotel, Chicago, April 11-13.

Second Conference on Kinetics, Equilibria, and Performance of High-Temperature Systems, Western States Section, The Combustion Institute, University of California, Los Angeles, April 14-16.

American Society for Metals Regional Conference and Exhibition, Materials and Materials Processing for the Petroleum, Petrochemical and Chemical Industries, Shamrock Hilton Hotel, Houston, April 17-19.

Western Space Age Industries and Engineering Exposition, sponsored by the governors of the 13 western states and leading western industrialists in cooperation with Department of Defense and other Federal procurement agencies, San Francisco, April 25-29.

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Stifling the 'One Human Asset'

WE RAN ACROSS some quotations in our holiday reading that we think bear considerable import for the missile/space industry, the Administration and the nation. The first is from Arnold Toynbee:

"To give a fair chance to potential creativity is a matter of life and death for any society. This is all-important, because the outstanding creative ability of a fairly small percentage of the population is mankind's ultimate capital assets, and the only one with which man has been endowed. The creator has withheld from man the shark's teeth, the bird's wings, the elephant's trunk, and the hound's or horse's racing feet. The creative power planted in a minority of mankind has to do duty for all the marvelous physical assets that are built into every specimen of man's non-human fellow creatures. If society fails to make the most of this one human asset, or if, worse still, it perversely sets itself to stifle it, man is throwing away his birthright of being the lord of creation and is condemning himself to be, instead, the least effective species on the face of this planet."

Here is the second quotation:

"The issues of proprietary rights in data have brought about a seriously disturbed climate which is not conducive to the collaboration and cooperation which must exist if the desirable government-industry partnership is to realize its full potential. Inventive American industry, both large and small business, is convinced that the attitude of government is unreasonable and that such mandatory regulations as represented by ASPR IX, part 2, MIL-D-70327 and MCP-71-77 are unfair and unworkable."

The second statement, while perhaps not measuring up to the literary standards of historian Toynbee, is closely allied to the same philosophy and carries with it the backing of a large and influential portion of our industry. It is from a report to Sen. Smathers (D-Fla.), chairman of the Government Procurement Subcommittee of the Senate Small Business Committee. The report was prepared by a military procurement advisory committee appointed by the senator.

To give some idea of the broad cross-section of the industry represented by this committee, we will cite the names of only a few of its directors and associate directors: E. D. Carter, Corporate Director, Materiel and Procurement, The Martin Co.; Dr. Thomas P. Cheatham, Jr., Vice President, Litton Systems; J. Leonard Comegys, Divisional Attorney, Bendix-Pacific Division, The Bendix Corp.; A. A. Farrar, Director of Government Contracts, Raytheon Co.; C. N. Rees, Executive Vice President, Standard Steel Corp.; Harvey Riggs, President, International Electronic Research Corp.; Denham S. Scott, Assistant to the President, the Garret Corp.; and William B. Webber, Vice President, Tektronix, Inc. Chairman of the committee was Carl G. Hokanson, President, C. G. Hokanson Co.

Both large and small business were represented on the committee. Some 50,000 man-hours went into compilation of the report, which covers the most important aspects of military procurement, pointing up shortcomings and making recommendations for corrective action. It is a document which will receive close congressional attention.

Our quotation is from the chapter on proprietary rights and is chosen because of the recent news that the Administration has drafted a National Inventions Act. This would give the government broad new patent rights, including title to all patents developed by private industry under government research and development contracts. As drafted the act also would require the industry to share royalties with the government on all commercial licenses and require compulsory licensing after three years with a limitation on the royalty fee.

If legislation along these lines is submitted to Congress, it must be considered unacceptable.

The Smathers report points out that the underlying factor enabling a business enterprise to maintain its competitive position in a free enterprise is its ability to develop inventions, special processes and know-how applicable to its products. This, surely, is an obvious fact. Yet the government attitude on proprietary data cannot be said to provide adequate recognition of it.

THE COMMITTEE put the result bluntly: "The government's continued insistence on obtaining this information will no doubt cause many companies not to do business with the government on that basis, or increase their prices to recover their investment or whatever value they place upon these rights."

The nation cannot afford any of these actions. We suggest to those concerned with the proposed National Inventions Act that they read the Smathers report closely, if they have not done so. We call their attention to the committee's recommendations, including the one aimed at improving the relationship between prime and subcontractors on proprietary data.

We cannot afford to stifle today the initiative the nation needs. Yet we are in danger of falling into the very trap of which Toynbee warns.

We suggest to the gentlemen of the administration and the Congress that they also re-read our first quotation—carefully and thoughtfully.

William J. Coughlin

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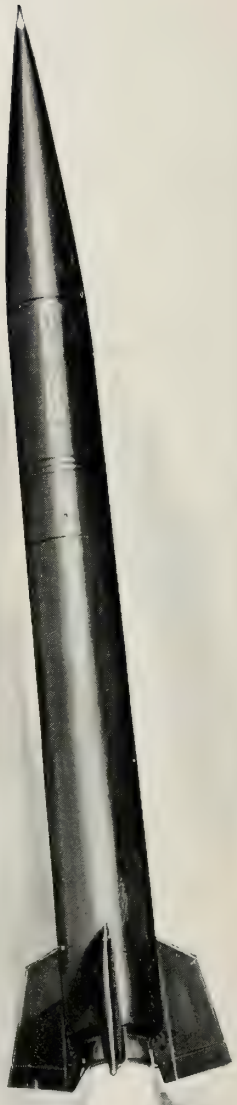

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missiles and rockets

THE MISSILE/SPACE WEEKLY

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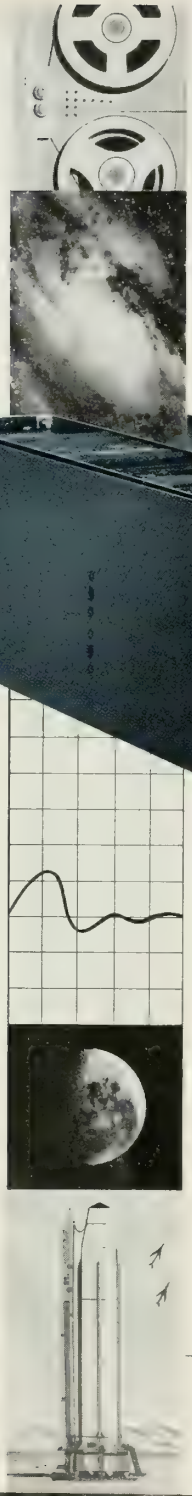

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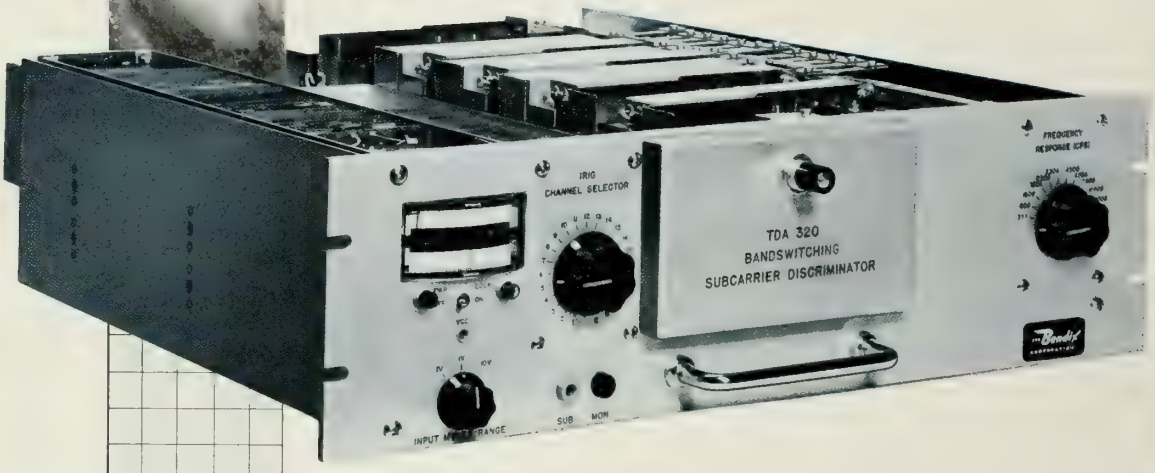

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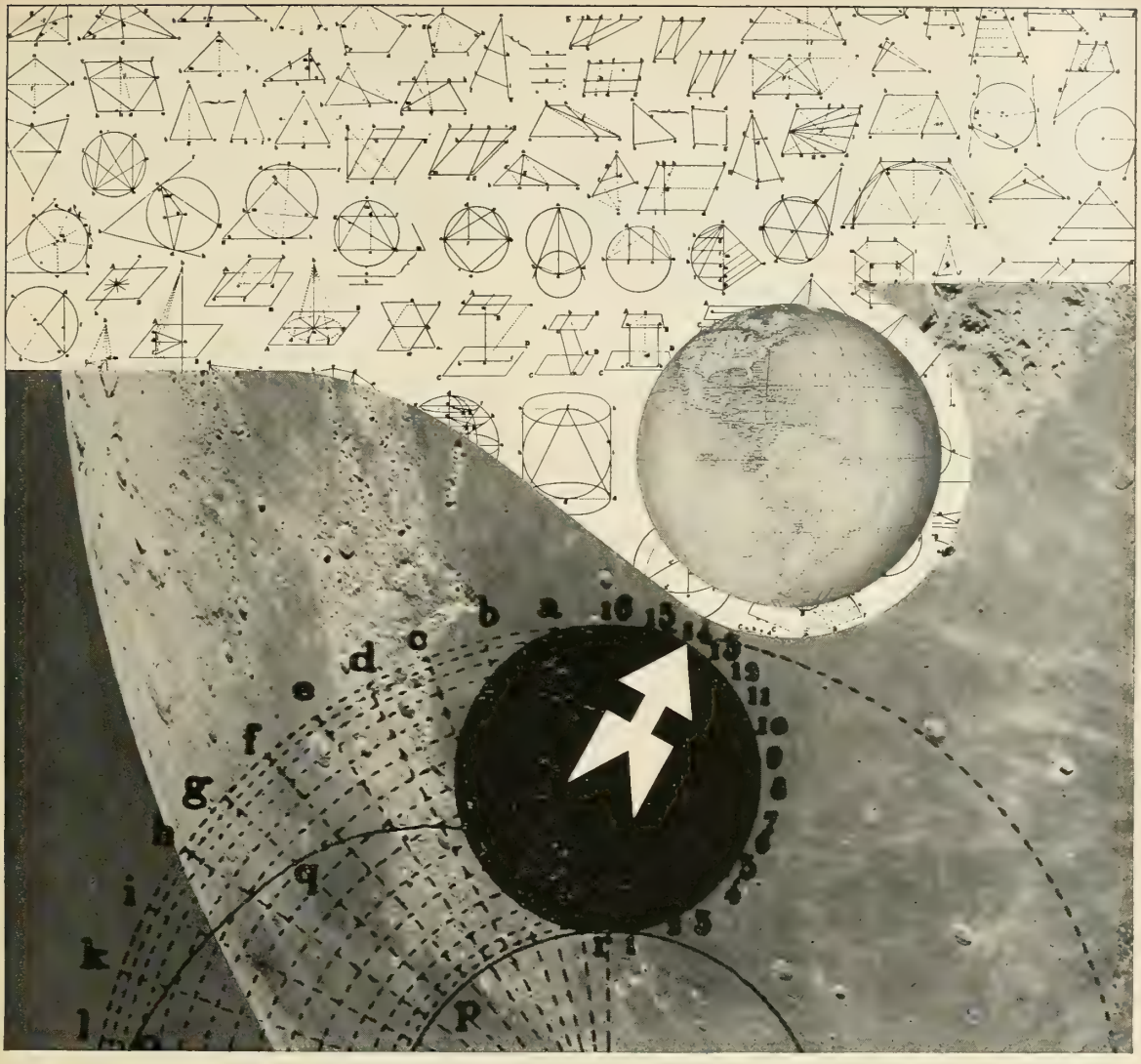

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THE MISSILE / SPACE WEEKLY

missiles and rockets

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THE COVER

Dr. Harold W. Ritchey, Thiokol's Vice President in charge of rocket operations, sees a possible "national tragedy" in U.S. failure to press for a big solid super-booster for lunar landing. *See p. 13.*

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†U.S. Reg. Pdg.

38,238 copies this issue

A Man's a Man for A' That

To the Editor:

In M/R, Jan. 1, I took particular note of Associate Editor Heather David's article ("Scientist/Engineer Shortage Worsens," p. 12) on the increasing shortage of graduate engineers as related to the Aerospace Industry and government.

This article notes that approximately 106,000 new scientists and engineers will be required annually through 1970, or roughly 60% more than were awarded degrees in 1960. This is very rough indeed! I agree wholeheartedly with the NASA philosophy of developing a greater level of interest in engineering and science on the high school level, and this effort can be even more fruitful with industry's participation. The theory is great, but what of the critical six to eight years immediately facing us?

I believe that Mrs. David touched on the answer to this critical question in her statement that "the only other source is persons without degrees." As an unlettered professional directly and indirectly associated with the missile industry for the past seven years, I have had occasion to examine this possibility quite thoroughly. My contention is that the non-graduate "semi-professional" can and will be the answer to the problem.

To make use of this able pool of manpower, both industry and government must take a long look at their respective methods of qualifying personnel for specific positions. Many organizations have missed the services of numerous well-qualified, ambitious and deserving applicants merely because the organizations' minimum qualification requirements were set too high for the positions offered. When industry and government come to the realization that "something must be done" let that something be the utilization of the semi-professional. Many excellent graduate engineers now functioning in administrative and semi-technical positions could then be released to practice technically in their chosen career fields.

With the grinding of my ax completed, let me add that the non-graduate who does manage to succeed in our present technical society must have a lot on the ball. 'Nuff said.

Warren E. Hanson
Senior Planning Engineer
Martin Marietta Corp.
Aerospace Division
Denver

To the Editor:

I have just read with much interest your article on the worsening shortage of scientists and engineers.

Why the decrease? Another theory that you may add to those that have been propounded regarding shortage of engineers is that many so-called "old" engineers (45 to 65 years of age) have been cast out. These "old" engineers can save millions of dollars, in time wasted by young engineers, due to their past experience in design because they do not have to go through that trial-and-error period *all* engineers have to go through. Also, more experienced supervision of groups of young engineers is the answer to this shortage problem. Why? Because young engineers are thrown into problems that they cannot cope with due to their limited college training; therefore they have been pushed into the background in so many companies that did not take the time to develop their initial knowledge through the experience of older and more farsighted engineers. What happens? The young engineers advise their friends that the engineering profession is "for the birds" and to go into something else.

Engineers are developed not in a day or a month or a year, but through constant training based on hard-core experience.

This letter is being written for two reasons—first, I am one of those "old" engineers (52 years of age) trying to get a job either with NASA, with Chrysler, or with one of the other large government contractors, but with no success. I have, as most "old" engineers have, the ability to supervise the design and development of the ideas of those few geniuses who will be responsible for our space program.

Second, if—and I have seen this in quite a few places—companies would refrain from using engineers in strictly clerical jobs, there would not be an acute shortage.

Harold A. Weinbaum, PE
Sheffield, Ala.

Spotting Nike-Zeus

To the Editor:

Your issue of January 1 contains an article on page 8 ("Shots of the Week") concerning the *Nike-Zeus* A-ICBM test over White Sands Missile Range, Dec. 14.

The accompanying photograph was that of a 64-gram pyrotechnic flash charge produced by the Pyrotechnics Laboratory here, which is used for spotting purposes and not that of an explosive burst.

Stanley Resnick
Assistant Chief
Pyrotechnics Laboratory
Ordnance Corps
Picatinny Arsenal
Dover, N. J.

Navy RDT&E Report

To the Editor:

Congratulations on your excellent report on Navy research and development in the Jan. 1 M/R.

R. W. Sheehy
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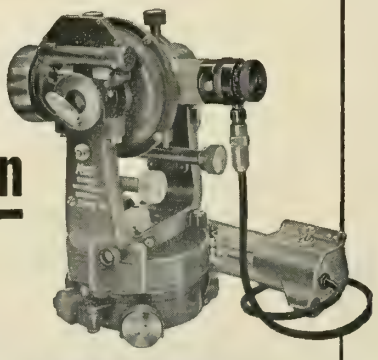

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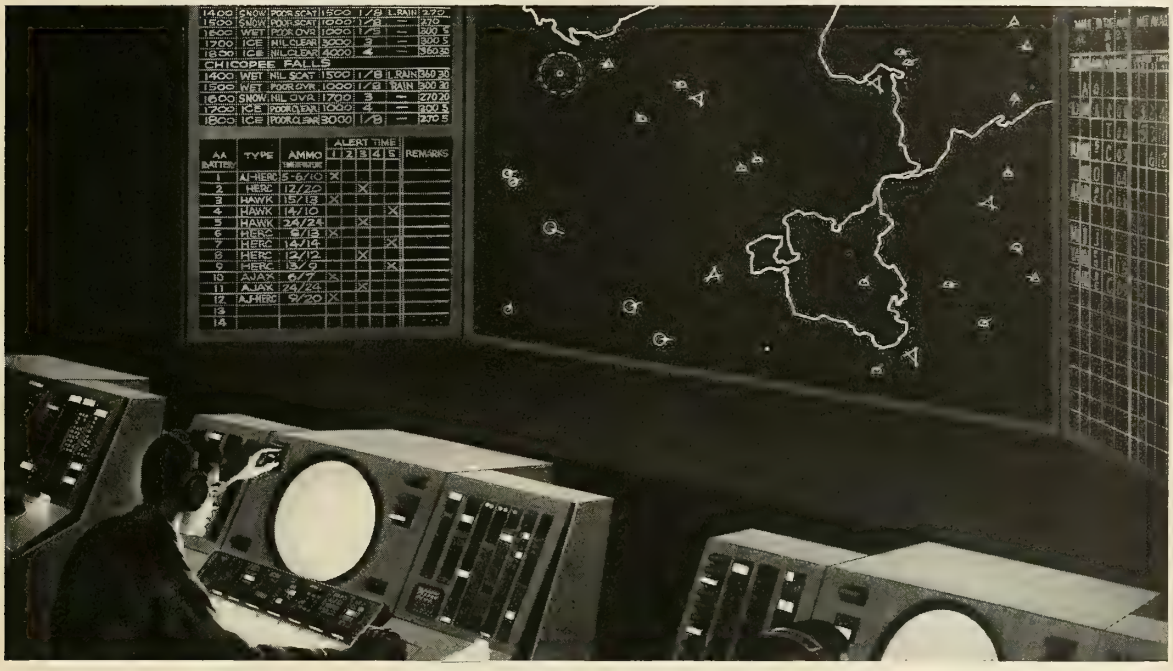

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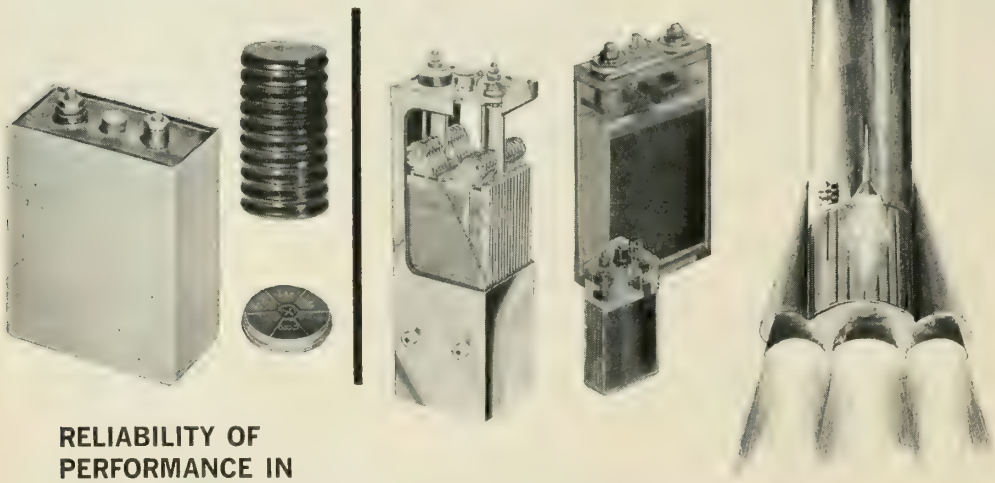

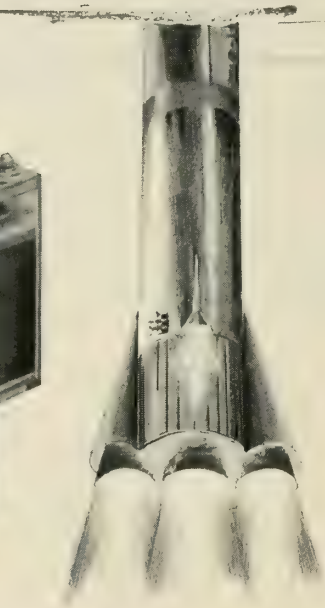

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WASHINGTON

Big Solids and the Hill

Congress is almost certain to take a hard look at the Kennedy Administration decision to put off the urgent development of *Nova*-class solid boosters (see p. 13). The House Space Committee was one of the big backers last year of an all-out solid-fuel booster program. It may not feel too kindly about finding that virtually nothing has been done on the program in the past six months.

Military-Man-In-Space

The Air Force is ready to zero in on Congress with some facts and figures on the Soviet threat in space. Several highly placed Air Force officials have been spreading the word that the Russian threat is "obvious"—and that it is high time the U.S. got military spacecraft development off the ground.

ComSat Action Coming

President Kennedy has put his stamp of approval on an Administration plan to provide wide ownership of a commercial communications satellite program. Legislation to implement the plan is expected to be handed to Congress shortly.

Soviet Space Report

Look for what could be a jolt to the U.S. space program: a staff report from the Senate Space Committee on Soviet space progress. The report will be out in a month or two. The committee's staff also has reports due on communications and weather satellites and U.S.-international space programs.

Missile Destroyer Squadron Readied

The Navy expects to deploy its first missile destroyer squadron on July 1. Operating out of Norfolk, Va., the nine-ship squadron will all be armed with *Asrocs* and either *Tartars* or *Terriers*.

Men from Ward 8

COUNTDOWN hears the Air Force is launching a new program to monitor the mental condition of personnel in its strategic strike forces—from missile pads to bombers. Reason: To make sure no one headed for a crack-up is allowed to handle nuclear weapons.

INDUSTRY

Bullpup, Sparrow III Outlook Bullish

The apparent Air Force preference for the Navy-McDonnell F4H for tactical and close support missions may result in more production for the Martin *Bullpup*. Likewise, if the Air Force chooses the F4H for air-defense intercept missions, orders probably will go up for the Raytheon *Sparrow III*.

Okay for Advanced Saturn Complex

NASA is asking for funds in the FY '63 budget to build a three-pad complex at the Cape for the Advanced *Saturn*. It will have a canal-barge transportation link. Completion date is expected late in 1964—in time for the first scheduled launch in 1965.

Wooldridge Steps Out

Effective Feb. 1, Dr. Dean E. Wooldridge is resigning as president of Thompson Ramo Wooldridge Corp. Reason: "in order to devote his time to scientific and technical studies and activities." Wooldridge will continue as a director of both TRW and its subsidiary, Space Technology Laboratories. His replacement: TRW v.p. and general manager H. A. Shepard.

R&D Intelligence

The British are getting ready for advanced testing of the *Skybolt* ALBM at Eglin AFB using Vulcan bombers . . . NASA's Marshall Space Flight Center will conduct cold tests on the new RL-10 hydrogen rocket engine next month and move into hot tests in March . . . The Air Force Logistics Command, which lost a building in a fire at Wright-Patterson Field in November, is asking companies to resubmit data or reference material to the Packaging and Materials Handling Division—which had its records destroyed.

INTERNATIONAL

Vigilant—Two Warheads

The British are fitting the new *Vigilant* antitank missile with a hollow-charge warhead for use with the British Army. For export models, the missile will have the Swiss "Energa" warhead made by Constructions Méchanique du Leman.

French Gear Up Missile Sales

A Department of Expansion and Exportation has been established in the French Defense Ministry. The new agency will bring new weapons—including missiles—to the attention of potential foreign buyers.

Cosmoplane vs. Aerospace Plane

What apparently would be a counterpart of the U.S. Aerospace Plane, the Cosmoplane, is being proposed by Soviet aircraft designer Artem Mikoyan. He envisions a spaceship which would be launched by multi-staged rockets and be capable of operating both in space and the atmosphere.

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The Missile/Space Week

Soviet Space Threat 'Increasingly Obvious'

The Air Force is renewing its drive for a military man-in-space program.

Addressing an Aerospace Medicine meeting at San Antonio, Tex., Maj. Gen. C. H. Mitchell said the "Russian threat in space is becoming obvious.

"The two Russian manned orbital flights are not isolated events," said the vice commander of the Air Force Systems Command.

"They are the latest accomplishments of a carefully planned, single-minded Soviet effort to achieve a manned military capacity in space. For the Soviets realize that if they can determine a way to dominate space they may be in a position to dominate the world.

"Clearly it is our responsibility as a nation to insure that space is used to benefit all mankind.

"We can insure this only through development of the ability to conduct military operations in space with maximum effectiveness."

Besides being better than machines, Mitchell said, man also has a potential role in satellite and missile observation systems.

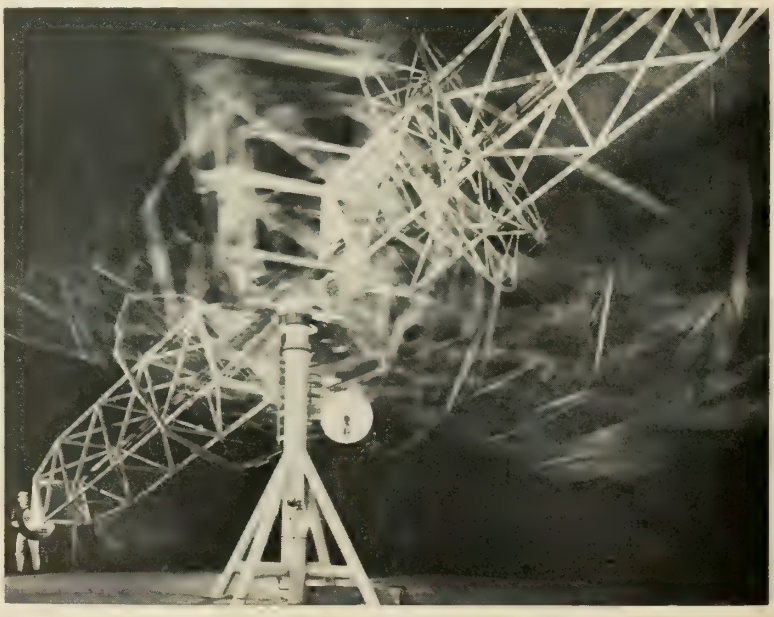
"As an observer, he could maintain watch over events occurring on or near the earth's surface, such as troop. ship, aircraft, missile, or satellite movements. His ability to observe. evaluate and make judgments could provide an information filter that would reduce the requirement for complex electronic data storage and transmission equipment."

Shots of the Week

A successful, 3200-mile shot from an underground silo put the Air Force's *Minuteman* "instant ICBM" program back on schedule last week.

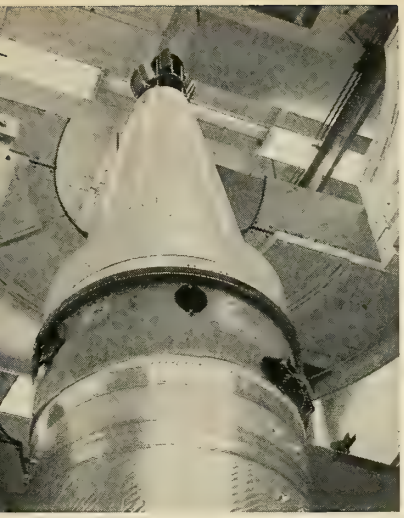
The launch, on Jan. 5, was the third success in a row for the *Minuteman* from its buried silo launch pad. A top official close to the program said the shot "put us right back on schedule."

This means that barring any major



Creating Frictionlessness for Centaur

GENERAL DYNAMICS/Astronautics' new space vehicle simulator designed to check Centaur's control system under space conditions. The test stand duplicates the frictionless state the launch vehicle encounters while coasting in orbit.



SNAP Unit Atop Agena

NEWLY RELEASED photo of SNAP 10A payload on Agena launch vehicle. It will be used as orbiting vehicle in AEC tests of nuclear-electric power systems.

problems the first nuclear-tipped missile will be installed in an operational launching silo later this year.

The launch was the seventh in the *Minuteman* series. The first launch from a "silo" was unsuccessful, but the problem has been solved in the last three launches. The Air Force recently awarded The Boeing Co. a $32.7-million contract for research, development and testing of the missile.

In another launch development, the engine of the *X-15* research plane failed to ignite, but the pilot glided the craft to a safe emergency landing.

It was the first time in the 2½ years and 47 launchings of the research program that the rocket plane's engine failed to ignite following the drop from the B-52 mother plane.

Navy Cmdr. Forrest S. Peterson was at the controls of the flight, which was to test the plane's stability at various angles of flight attack.

Goldberg Calls on Martin

Labor Secretary Arthur Goldberg will visit the Baltimore plant of Martin Marietta Corp. this week to examine the impact of layoffs resulting from government procurement policies.

Goldberg said he wanted to make a case study of the Baltimore situation.

About 2500 skilled employees were laid off at the plant recently, shortly after Martin failed to obtain the prime contract for development of the *Apollo* spacecraft.

McNamara Booked Solid In Congressional Hearings

Military posture hearings are scheduled tentatively Jan. 19 before the Senate Armed Services Committee.

Secretary of Defense Robert McNamara will make the principal statement during the hearings, which are expected to require two or three days.

The House Armed Services Committee will hold similar hearings on Jan. 24-27.

McNamara will also testify on budget requests for military construction before the Senate committee in the last week in January and the House committee in the first week in February.

The backbreaking schedule will show whether McNamara's honeymoon with Congress is over.

Last year, he got all the funds he wanted, and several items, such as more bomber money, which he did not want.

Controversial developments, principally involving U.S. Reserve forces, may spell trouble for the former Ford Motor Co. president.

The House Military Appropriations committee, headed by Rep. George H. Mahon (D-Tex.) has scheduled the Defense Department Secretary for a week-long appearance.

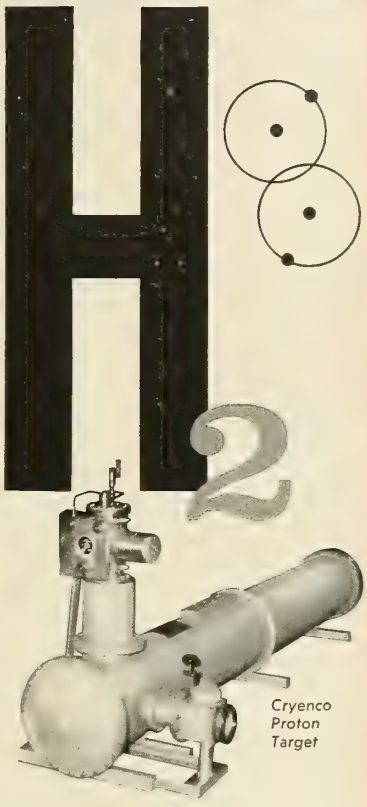
The Senate Armed Services Subcommittee, headed by Sen. John Stennis (D-Miss.) will begin on Jan. 23 a prolonged study of DOD security review and public information procedures. Main topics which will be discussed include: details of censorship of more than 1500 speeches by the Administration, troop education and indoctrination methods, policies related to armed services public information seminars.

Another Underground A-Shot

The U.S. exploded another low-yield nuclear test shot last week—the first in 1962.

The Atomic Energy Commission defined the shot as one having an explosive force of less than 20,000 tons of TNT.

CRYOGENICS



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Aerospace Vehicles Engineers

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Structures

Senior Dynamicist. Must be capable of performing advanced analysis in structural mechanics. Will be required to calculate response of complex elastic systems to various dynamic inputs including random excitation. Must be capable of original work in developing advanced analytical techniques.

Loads Analyst. To establish structural design criteria for advanced missiles and spacecraft. Should be capable of determining external airload and inertial force distributions.

Reliability Analyst. To perform statistical analysis of structural loads and strength properties for the purpose of establishing structural reliability criteria on a probability basis.

Stress Analyst. To perform advanced stress analysis of complex and redundant missile and spacecraft structures. Will be required to solve special problems in elasticity, plasticity, short time creep and structural stability.

Design. Experience is required in preliminary and final structural engineering and design, including preliminary stress analysis. A knowledge of the effects of extreme temperature environment and hand vacuum, plus a background in materials is desired.

Heat Transfer

Space Vehicle Heat Transfer. Basic knowledge of radiation conduction and convection heat transfer with application to thermal control of space vehicles is required. Knowledge of spectrally-selective radiation coating, super-insulations and thermal vacuum testing is of particular value.

Aerothermodynamicist. Experience in hypersonic real gas dynamics, heat transfer, abalation; re-entry vehicle design, detection; shock layer, wake and rocket exhaust ionization; and anti-missile system requirements will be most useful.

Equipment Installation

Packaging and Installation Engineer. To perform optimum packaging and installation design for missile and/or spacecraft units, considering amount and geometric shape of space available as well as weight and center of gravity distribution requirements. Must be capable of analyzing structural adequacy of unit under extreme environmental conditions.

Controls

Optical Devices. Design, development, procurement and test operations are involved. Considerable experience in the field of optical devices for space applications such as star, horizon, sun and moon trackers.

System Test. To plan and supervise the operations of a flight control system laboratory. Air bearing tables and a wide variety of optical mechanical and electrical equipment are involved.

Control System Analysis. Requires engineers at various levels of experience including senior men capable of taking over-all project responsibility in the synthesis and analysis of control systems.

Circuit Design and Development. Experience in design and development of transistorized control system circuits, including various types of electronic switching and modulation techniques is required.

If you are a graduate mechanical engineer, electronic engineer, physicist or aeronautical engineer, with experience applicable to the above openings, please airmail your resume to: **Dr. F. P. Adler,** Manager, Space Systems Division, Hughes Aircraft Company, 11940 W. Jefferson Blvd., Culver City 21, California.

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Solid Nova Priority Dropped

Thiokol's Ritchey hits delay in multimegapound-thrust boosters as a 'national tragedy' in the making

by James Baar

THE KENNEDY Administration has abandoned a decision made last May to develop a solid-fueled *Nova* superbooster on an urgent basis for the initial manned lunar landing.

The U.S. will rely instead on rendezvous using liquid boosters, and the liquid-fueled *Nova* as a dual approach to the moon.

This setback for big solids—particularly the loss of more than six months of development time—is causing grave concern in the solid-propellant industry. Thiokol Vice President Harold W. Ritchey, one of the leading advocates of solid superboosters, says of the delay:

"If we want to beat Russia to the moon, we are courting a national tragedy."

The 15-20-million-lb.-thrust solid superbooster was a major element in the greatly accelerated space program that the President called for on May 25 in an address before a Joint Session of Congress. He said:

"We propose to develop alternate liquid- and solid-fuel boosters, much larger than any now being developed, until certain which is superior."

Subsequent testimony before congressional committees made clear that work on the 1.5-million-lb.-thrust F-1 liquid engine and the multimegapound-thrust solid motor would proceed at the same urgent pace over the next two to three years. At that time, a decision would be made as to which would be used to launch manned *Apollo* spacecraft to the moon.

The Air Force, which was assigned the solid superbooster development job, requested and received from Congress $62 million — including $12 million for facilities—for the program for FY '62, plus $15 million for work on a new upper stage for *Titan II*.

At the time, Dr. Harold Brown, Pentagon R&E Director, estimated that the cost of developing a solid superbooster suitable for clustering as a *Nova* would total about $250 million.

• **Nothing doing**—In the intervening period, however, no major steps have been taken toward implementing such a program. And none appear imminent. No facilities have been built—and none are in the planning stage.

Very little of the $62 million appropriated by Congress has been obligated—and this only for "state of the art" studies. When the money is spent, it is expected to be redirected largely into the 120-in. motor program.

Despite this, NASA said this week when queried by MISSILES AND ROCKETS that there had been "no change" in the President's May 25 decision.

Nevertheless, it is apparent in the NASA-directed *Apollo* program as it stands today that the agency is relying entirely on large liquid engines for the early conquest of the moon and has chosen to ignore a concurrent solid approach. Here's the plan:

—Work on the *F-1* liquid-fueled booster which will be clustered into an eight-engine *Nova* will continue at a rapid rate. This *Nova* would be suitable for launching an *Apollo* directly from the earth to the moon.

—Work on developing space rendezvous techniques is being greatly accelerated, along with development of the *Saturn C-5* or *Advanced Saturn*, a cluster of five *F-1's*.

—The Air Force will press forward with the development of big solid boosters. However, these will be the 120-in. motors designed primarily to fulfill military space requirements rather than the approximately 240-in. motors proposed for *Nova* and *Apollo* launchings — which Ritchey says have been proven feasible.

• **Slow down** — Air Force and NASA officials still are planning the development of solid multi-megapound motors, but at a much slower pace. They are now generally regarded at the decision-making level as a "follow-on" development to the 120-inch models—which will provide 500,000 to more than 1 million pounds of thrust.

Ritchey and a number of other solid propulsion experts both in industry and the government feel that this approach toward solid superboosters is unnecessarily crippling to America's efforts to beat Russia in landing a man on the moon. And it is in the light of the East-West race to the moon that Ritchey characterized delay in the solid superbooster program as a "national tragedy."

"We ought to go after the solid-rocket business like we really mean business," he said last week in an interview with MISSILES AND ROCKETS. "Instead, we are finding all of the reasons why we shouldn't do it."

Ritchey said that over the years solid propellants have continually proven their value and—just as continually—they have been forced to prove it over again.

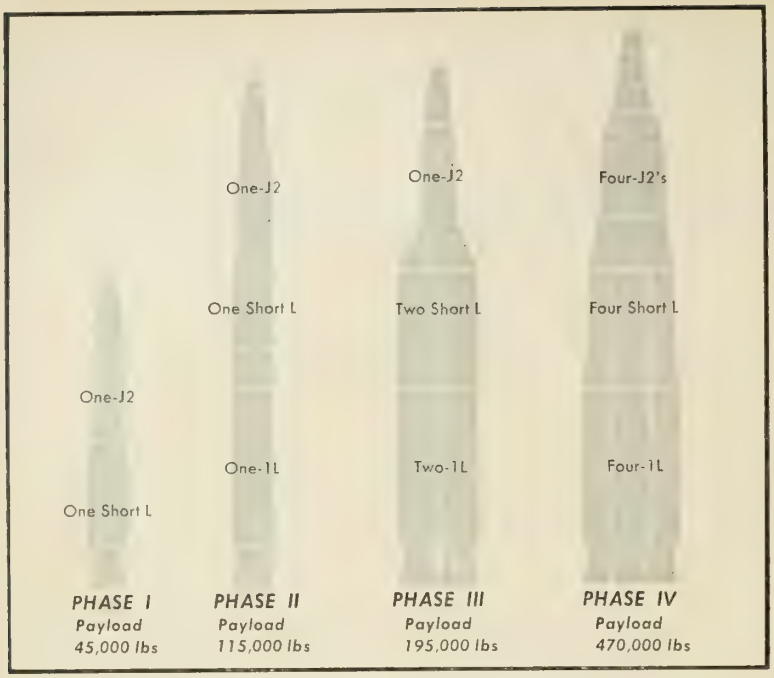
"The pattern has been pretty steady," he said. "We wasted a lot of money on liquid IRBM's and then went to the solid *Polaris* and *Pershing*. We wasted a lot of money on liquid ICBM's, then finally went to the solid *Minuteman*.

"Now we see the same thing happening on the big boosters. The problem, as usual, is the lack of confidence and experience in solids among people at the policy-making level."

• **Early offer**—The fight of solid-propulsion experts for the early development of a multi-megapound solid booster broke into the open nearly a year ago at hearings held by the House Space Committee.

At that time, officials of Thiokol, Aerojet-General and other solid-propellant manufacturers testified that they could develop a solid superbooster motor in the 2-million to 3-million-lb.-thrust class in 24 months or less.

Ritchey told the committee on March 8 that his firm could develop a flyable solid multimegapound motor in



Thiokol's New 20-million-lb.-thrust Proposal

THIOKOL CHEMICAL CORP. unveiled a new proposal this week for building a 20-million-lb.-thrust solid-fueled superbooster with the first hardware to fly in 18 months. Cost: "Less than $240 million."

The proposal—under consideration by the Air Force and NASA—is aimed at developing a vehicle which could send a man direct to the moon in 1966-67—if it is implemented promptly.

Producing flight hardware in 18 months would involve an accelerated pace and doubling of facilities. Thiokol said the program could be accomplished for less than $200 million if the first firing were in 22 months. Completion of testing and delivery of a booster would then span 40 months, instead of 30 on the accelerated schedule.

As diagramed above, the superbooster development program would be divided into four main phases: 1) prototype demonstration, 2) engineering and development of the full-scale 100-ft.-long and 240-in.-dia. motor, 3) preflight rating in a cluster of two, and 4) delivery of the complete stage.

Takeoff weight of the complete vehicle is pegged at about 17 million lbs.

The company says the booster stage would have a burning time of 100 secs. (Payloads indicated above are computed on the basis of 99-n.m. orbits.)

Each one of the 240-in. motors could be uprated from five million to six million pounds thrust by extending the length to 120 ft.

• **Geared to barges** — *Thiokol has side-stepped the segmented approach and envisions the production of monolithic motor cases. Full technical details of the proposal were not disclosed. But the company says heat-treating facilities for such cases are already available and loading and test facilities could be built economically if designed around barge transport.*

The motor case would be brought by barge into a basin equipped with a lock so that it could be connected by a trunion to the fuel-loading plant at water level. The water would be drained, permitting the 100-ft. case to swing on the trunion into a verticle position for casting and testing.

The basin would then be reflooded to float the motor back on the barge for transport to the launch site.

• **Slaps at liquids**—*Dr. Harold W. Ritchey, Thiokol vice president, said "man-rating" of large solids should not be considered a problem, since solids in missiles already have proven to have a high safety factor. "In liquids there are many more modes of failure," he said. "Chamber pressure is the critical point in solids, and we can instrument for that."*

In another thrust at big liquids, he said "we could beat the Saturn C-5 with a solid." The pacing item for building a big solid is the clustering of J-2's "for the hydrogen-oxygen upper stages.

"If we move now . . . we should be able to do something in 1966."

18 months under an urgent program. Moreover, he made clear for anyone who may have missed his point what this schedule meant in comparison with the time needed for development of a liquid-fueled *Nova*.

"I think you will find," he said, "that any propulsion engineer who examines this question objectively without a preconceived conclusion will come to the same conclusion that many of us have come to—and it is simply this:

"If you want high thrust to lift heavy loads, then the first high-thrust stages can be accomplished much more easily and quicker by the use of solid rockets."

Both the Administration and Congress bought the argument at least to the point of developing a solid superbooster on a simultaneous, urgent basis along with the liquid superbooster.

Deputy Defense Secretary Roswell Gilpatric told the Senate Space Committee last June that "until about three years from now, by the end of 1964, when we will have had this solid-propellant motor through static tests and the F-1 engine in the *Nova* has been tested, it would not be safe, in my judgment, for this country to rely on a single approach.

"Here we have two types of technology," he said. "It is important in the judgment of the Administration that all of us agree that we should put off gambling or putting all our bets on one approach to this very important large booster which is necessary if we are going to put a man on the moon and bring him back safely."

An important change since then is the introduction of the new alternative: rendezvous. But some experts argue that the rendezvous project as now planned is not a true alternative because it will still rely solely on a cluster of liquid F-1's as will the direct approach with *Nova*.

• **New proposal**—As interest in the solid superbooster for *Apollo* waned, Thiokol and Ritchey late last year approached program managers with a new proposal for a family of multi-mega-pound motors (see box). They ran into the same opposition that they and others had found earlier.

"It is a terrible mistake," Ritchey said last week. "From the standpoint of time, schedules and reliability, we have the liquids beaten. Even with the months that have been lost. Only when you get into the matter of cost does the issue become more controversial and, depending on such factors as how many motors are ordered, I believe solids can be cheaper."

Asked to state precisely what he thought the Administration ought to do, Ritchey snapped: "Something!" ⠿

In new session of Congress . . .

Outlook Good for Record NASA Budget

THE SECOND SESSION of the 87th Congress will be a crucial one for the U.S. space program.

Most important issue will be NASA's request for a record budget of approximately $4 billion. A major cut would kill this country's already slim chances of beating Russia to the moon.

Also slated for congressional consideration is NASA technical progress, and legislation affecting a commercial communication satellite system and government patent policies.

The outlook for approval of NASA's fund request appears good, despite the fact that the first U.S. manned orbital flight has slipped into 1962. Technical problems also continue to plague the *Centaur* and lunar-exploration programs—adding fuel to possible congressional fires.

• **Key backing**—Senate Democratic leaders indicate down-the-line support of the Administration's space plans.

In the House, Space Committee Chairman Rep. George Miller (D-Calif.) told MISSILES AND ROCKETS "I know there is going to have to be a high budget increase over last year. I will support the President's request within certain limits."

Miller refused to say what the limits were until he had seen NASA's request.

His counterpart in the upper chamber, Sen. Robert Kerr (D-Okla.) said flatly "I will support the President's program." Sen. Warren Magnuson (D-Wash.), chairman of the Senate appropriations subcommittee which considers NASA's budget, echoed the same sentiment, declaring that "I expect to support the President's program as it unfolds throughout the year."

As for U.S. space failures, Kerr said "in a program involving such difficult scientific achievements, uninterrupted successes would be impossible, but the percentages of failures have been less than anticipated and the favorable results greater than should be expected."

The support of the top Democratic leadership should clear the way for approval of most of NASA's funds. As in the past two years, congressional observers expect the legislators to make a token cut in space expenditures.

Also improving the outlook is the fact that much of the new facility funds —which will account for a large part of the budget—will be spent in the Southland. This will undoubtedly blunt much of the traditional Southern Democratic conservative approach to high budget requests.

• **ComSat hurdle** — Principal issue in the communications satellite battle which is shaping up concerns whether or not missile/space firms will be able to share in the ownership of a commercial system.

Sen. Kerr is scheduled to introduce legislation to restrict ownership to communications carriers. The Administration, however, will send to Congress in the near future a bill providing for wide ownership by corporations and individuals.

Sen. Kerr told MISSILES AND ROCKETS that he feels his bill is only the basis for discussion of an ownership plan. This indicates that he is amenable to accepting or settling for a compromise with the Administration view.

A jurisdictional battle is already developing over just what committee will have primary responsibility for the legislation. In the House, the Commerce Committee has indicated it intends to hold public hearings on the subject. While an inter-committee dispute could kill the legislation, members of Congress close to the situation feel that a compromise will be worked out.

• **Patent puzzle**—The only hope for enactment of major patent legislation rests with the evolvement of a common Administration position. Because of the divergent areas of interest and emphasis among government agencies, this will not be easy. ⌗

First Stage of Saturn C-5 To Have Five F-1's

THE FIRST STAGE of NASA's advanced Saturn booster will be powered by five F-1 engines developing 7.5 million lbs. thrust.

The three-stage vehicle, the space agency announced, will be capable of placing 110-ton payloads into earth orbit, making it ideally suited for planned orbital rendezvous flights. For space-probe flights, it will be capable of sending 90,000-lb. payloads to escape velocity.

Prime mission for the advanced Saturn will be to launch the Apollo spacecraft on manned circumlunar flights. If orbital rendezvous is used, it will also serve as the launch vehicle for the manned lunar landing flights with the spacecraft.

Engines for all three stages are scheduled for delivery in 1963. First launch of the big booster from Cape Canaveral is slated for 1965.

The second stage (S-II) will be powered by five J-2 engines which will generate a total thrust of 1 million lbs. Its third stage (S-IVB) will have a single J-2 with 200,000 lbs. thrust. This will be used only during escape missions. Only the first two stages will be used for earth-orbit flights.

Space agency officials said that the advanced Saturn designation for the vehicle will be dropped in the next couple of months and a new name will be substituted. At the same time, the smaller-thrust Saturn C-1 vehicle will be identified simply as Saturn.

Both the F-1 and J-2 engines are being developed by the Rocketdyne Division of North American Aviation Inc. The F-1 uses kerosene and liquid oxygen as its propellant. Liquid hydrogen and LOX power the J-2.

The space agency said that the first stage, besides providing greater payload capability will also help to solve the base heating problem by reducing the channeling of heat from the burning propellent back into the engine section.

The five-engine second stage will provide an engine-out capability, since the engine cluster must be started in space.

The restart in space will be required if the advanced Saturn — through the use of orbital rendezvous —is used to send the Apollo spacecraft on manned lunar-landing flights.

The Boeing Co. has been selected to build the S-IB stage and Douglas Aircraft Co. is building the S-IVB stage. North American Aviation, Inc. is developing the S-II stage.

Navy Extends PERT To Gauge Program Costs

Polaris-proven computerized technique, in pilot-testing at GE and Lockheed, should avert some old misconceptions

THE NAVY has extended its computerized management tool—PERT (Program Evaluation and Review Technique)—to measure costs.

This means that the system that so successfully monitored development of the *Polaris* system on a "time" basis is now also formulated on a "cost" basis, to assist contractors and customers in the following areas:

—Planning schedules and costs.

—Determining time and cost status.

—Forecasting manpower skill requirements.

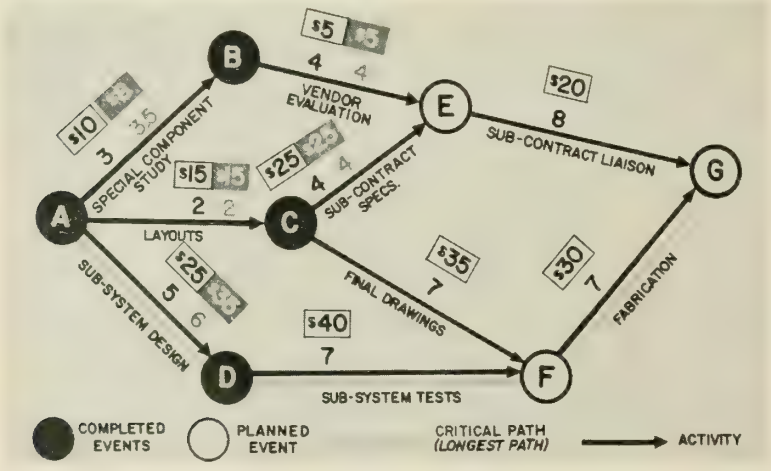
—Predicting schedule slippages and cost overruns.

—Developing alternate time-cost plans.

—Allocating resources among tasks.

Developed for the Navy Special Projects Office by Navy personnel and Management Systems Corp., the PERT/Cost system is being pilot-tested at General Electric Ordnance Department and at Lockheed Missiles and Space Co.

• **Old way versus new**—A standard way to keep track of costs is first to plot the curve of estimated costs on a time-vs.-cost chart, then add the curve of actual costs as they occur. Under certain not rare circumstances, this can lead to serious misconceptions.



SAMPLE PERT NETWORK shows estimated and actual time and cost information.

The first step in the PERT/Cost system is to construct a network consisting of the activities (project tasks) to be performed, and the events or milestones to be attained (M/R, July 17, 1961, p. 110).

After the network has been prepared and time estimates developed for the network activities, the manager sets up a schedule.

Once the schedule is established, estimates of resources needed to perform each cost-significant segment of the network are obtained.

Actual costs and times are collected separately for each cost-significant segment. These actual time and cost inputs are compared with estimates to indicate the project status.

The figure shown here contains a sample network with estimated and actual time and cost information. The completed activities thus far include activities A-B, A-C and A-D. Although activity A-B has consumed one-half week more than scheduled, it is on a slack path and the slippage will have no effect on total program duration.

The A-B activity was budgeted for $10,000 and actually required only $8000, a $2000 underrun. Activity A-C was completed on budget and on schedule. Activity A-D encountered difficulty and incurred a $10,000 overrun in cost and a one-week slippage in schedule. The slippage in this path required immediate attention, since A-D is an activity on the critical path.

Note also that activity B-E and C-E have consumed both their time and budget, yet are incomplete. New estimates to complete are required.

Outputs of the PERT/Cost system include time, cost and resource reports for various levels of management. Moreover, a primary output is the chart of the least expensive course which will yield the desired development-time schedule.

A copy of a booklet on "The PERT/Cost System" can be obtained from The Special Projects Office, SP-12, Navy Dept., Washington 25, D.C. ⌗

Medics Press Research on Weightlessness Illusions

SAN ANTONIO—U.S. space medics have stepped up research on disorientation occurring during weightlessness.

Since reports of the Russian Cosmonaut Titov's flight, scientists have become increasingly concerned with the problems of possible "sea-sickness" in space flights.

Conferees at the School of Aerospace Medicine's Annual Lectures in Aero-space Medicine were told that two types of optical illusions occur during weightlessness.

Although these illusions themselves may not be detrimental to operation of a space vehicle, the same mechanism which causes them may be responsible for "space sickness."

Air Force physicians have studied the phenomena during periods of weightlessness in F-100 jets. In one illusion, an isolated object viewed by the subject seemed to move. This same effect occurs if one twirls his body rapidly. It may occur in aircraft during rolls, spins or other types of rotary movement or during low angular acceleration.

Another visual illusion experienced during weightlessness causes objects to appear to be elsewhere than where they really are. This effect also has been demonstrated on the centrifuge.

The School is developing a new technique utilizing electrodes, helmet sensitive accelerometers (developed at Edwards Air Force Base) and electromyography to ascertain the dangers of these phenomena. ⌗

Sensors Function Well in Monkeys

by Heather M. David

THE AIR FORCE reports good results in its program of launching internally instrumented monkeys on *Atlas* missiles.

Although the monkeys did not fare so well (one was blown up and the other was not recovered) the telemetry data received during the flights were promising. The equipment was unique in that it was surgically implanted in the bodies of the 6-8 lb. rhesus monkeys.

The monitors provide data on the animal's physiological reaction to weightlessness, acceleration, vibration, intense heat and other stresses encountered during launch, flight and recovery.

The program is a test of a system which may someday be used on humans. Officials in the project say that internal sensors may be far superior to those attached to the body externally.

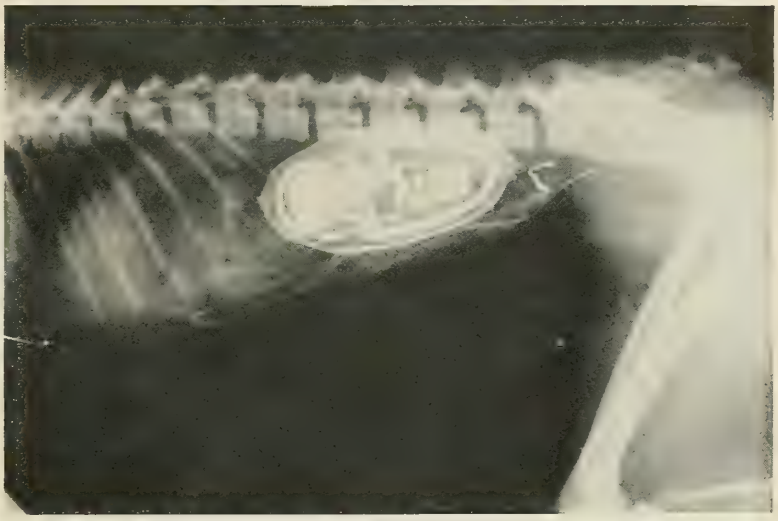
Those sensors transmitting only internal noise will not reproduce ambient cabin noises. Noise caused by the movement of the animal's body does not interfere with the transmission of vital physiological data. And the system has no external leads to encumber human pilots as they go about their duties.

The monkeys were carried along in routine tests of the *Atlas* missile in specially designed pods. A malfunction of the missile brought a fiery end to the Nov. 10, 1961, launch, and the ejected pod was lost Dec. 16, 1961.

More shots are expected, but no definite commitment has been made by the Air Force. The National Aeronautics and Space Administration also is expected to join the program.

• **Life support system**—The animal pod is a cylinder 30 in. in diameter by 102 in. long, attached to the sustainer portion of the missile. It is located radially between the vernier engine #2 and the B-1 missile equipment. North American Aviation is responsible for the life support system and is overall contractor for the program.

Some 30 seconds after the sustainer engine cutoff, the pod is ejected from the missile. It travels a ballistic course parallel to that of the missile and is supposed to be recovered in the impact area. The pod is equipped with a blunt nose fairing with ablative material for re-entry.



MONKEY X-RAY shows position of a surgically implanted transmitting system which monitors physiological processes in Air Force flights.

The monkeys ride in a fibreglass couch covered with polyurethane and spongerubber. The restraint system is covered with nylon net with an oval cutout for the monkey's face.

The monkeys were operated upon some time before flight and the transmitting apparatus placed near their kidneys. Sensing electrodes were placed near the heart and lungs.

The simians appear to suffer no discomfort and have no ill effects from the presence of the equipment in their bodies. Once the equipment is in, the animals are in a constant "ready for test" condition.

• **Sensing system** — The FM/FM system transmits respiration (low-frequency), electrocardiogram (medium-frequency) and phonocardiogram (high-frequency). It consists of two pressure sensors, a pair of ECG electrodes, three subcarrier oscillators, a rechargeable nickel-cadmium cell and an RF oscillator, and a recharging coil.

The output signals of the three subcarrier oscillators are mixed and the resulting voltage used to modulate a 45-megacycle RF oscillator located in a separate package. The signals are transmitted to a receiving antenna in the couch, and directed to a small FM receiver. The video output is connected to a three-channel discriminator where the subcarrier frequencies are separated from the composite signal by bandpass filters. The individual subcarriers are discriminated separately to recover the modulation frequency components. The three signals are filtered with low pass signals to remove the subcarrier frequency components and are presented in analog form for retransmission.

The equipment is potted in polyurethane, except for the antenna, which is first secured by a light coating of methyl methacrylate. This is to avoid carrier-frequency deviation due to mechanical effects on the loop antenna in a vibrating environment.

A light coating of Dow-Corning Silastic protects fragile components against shrinkage crushing. This material is biologically inert, preventing irritation, and soft, minimizing organ trauma.

Then monitor also registers capsule pressure and temperature, oxygen bottle pressure, voltage and current to the capsule recharging oscillator, and charging voltage and current applied to the airborne battery. ⌘

This is a new warning system designed by Northrop

Northrop has developed an automatic voice warning system for aircraft crews which gets action 4 times as fast as the traditional red lights. Called VIPS for Voice Interruption Priority System, it uses a female voice, speaking directly over the pilot's headset, to describe the exact nature of the hazard.

In recent tests, proficient pilots reacted to warning lights in an average of 12 seconds and some lights went unnoticed up to half an hour. With VIPS, the average time was just 3 seconds, *and no warnings went unnoticed.*

With VIPS, the pilot doesn't have to watch for warnings, nor figure out what they mean. The voice can be programmed to suggest remedial action. If several things go wrong at once, a logic network will select the most important and interrupt any lower priority warning.

VIPS was conceived, designed and developed to its present high degree of versatility by the Nortronics Division of Northrop. VIPS will be installed in all Air Force/General Dynamics B-58 Hustlers.

NORTHROP

echnical Countdown

ASTRONAUTICS

ore Gemini Details Revealed

In addition to a restartable engine for manuevering in ce during rendezvous operations, NASA's second-gen- tion *Mercury* capsule—*Gemini*—will have a series of cumferential flaps which can be deflected individually in groups to provide lift for the capsule. The idea, ording to informed sources, is to control the trajectory the spacecraft during re-entry and, thereby, considerably uce the recovery area necessary.

stronauts To Monitor Booster Lift-Off

Pilots of future spacecraft may be given more control er the vehicle booster, according to one top NASA official. e idea is not to let the crew "fly" the vehicle during e launch phase, but rather to give them the capability monitor the systems so that, in the event of a failure, ey would not be totally dependent on automatic escape stems.

F Hypersonic Flight Program Detailed

The Air Force, according to one official source, has odified its *Dyna-Soar* hypersonic test program. In lieu of rge-scale models of the space glider, the AF has designed special, 7-ft. vehicle with which it expects to test the ructures, flight dynamics and aerodynamic characteristics f *Dyna-Soar* at speeds well above Mach 20. Scheduled to egin early in 1963, the hypersonic program—called Project sset—will use the AF *Blue Scout* to launch the McDonnell ircraft Corp.-manufactured test vehicle.

ELECTRONICS

PMR Impact Predictor Operational

A new long-range missile impact predictor, GERSIS, s now operational at Pacific Missile Range, the Navy reports. The $3.6-million General Electric Range Safety nstrumentation System was built to extend Pt. Arguello's racking range well beyond previous capabilities. While t can be used for PMR or Vandenberg missile launchings, GERSIS was installed primarily for use with ICBM boosters o be employed in the upcoming *Nike-Zeus* tests over the Pacific. The system design is an outgrowth of the *Atlas* ICBM radio command guidance, and provides a continuous real-time display of missile trajectory and impact prediction.

Massive Statistics from Stanford

After eight years of dreaming, Stanford University is now on its way toward building its two-mile-long linear accelerator. The final system will employ 960 klystron amplifiers operating in banks at a frequency of 2.856 giga- cycles. Each klystron will provide up to 24 megawatts out- put in 2.5-microsec. pulses. Gain will be 4.5 Mev/ft. with a maximum energy of 40 Bev. Initially the linac will use only 240 klystrons for an energy gain of 2 Mev and a max. output of 20 Bev. Designed by Varian Associates and Stanford, the system is expected to cost $125 million and require six years to complete. RCA is development con- tractor for the klystrons; construction contracts are ex- pected to be awarded by Stanford shortly.

Bell Pushes CW Lasers

Bell Telephone Laboratory scientists, recently success- ful in development of a continuous-wave solid-state optical maser, now are known to be well advanced in developing intelligence modulation schemes and reception equipment for the high-intensity beams. The principal application is considered to be for long-range telecommunications.

ADVANCED MATERIALS

Second-Stage Minuteman Switches to Titanium

Aerojet-General is using titanium for second-stage *Minuteman* motor cases. The material is Titanium Metals Corp. Ti-6A1-4V alloy, and the chamber is 30% lighter than a comparable steel vessel. The weight savings can be translated into either more range or an increased payload.

Solid Chemical Bearing Price Cut

Glass-fiber-reinforced Teflon bearings—made perma- nently self-lubricating by adding molybdenum disulfide—are being produced in a new manufacturing process that cuts the cost to about a third that of previous prices. The Rogers Corp.'s process, Autoform, turns out bearings capable of vacuum operation between −425° and 575°F.

Ultra Clean Steel from New Process

Arkota Steel Corp. put Arizona in the ranks of steel- producing states through a new process using only natural gas and electrical power. The method produces highly pure steel from Arizona's low-grade ores through a reduction process using a controlled mixture of hot hydrogen and carbon monoxide gases.

Thiokol Fires at −50°F

Large 40-in.-dia. motors have been static-fired at −50°F at Thiokol's Redstone Division. The units had been sub- jected repeatedly to temperature variations between −50° and 135°F. Only flight-type components were used and the burning time of the HC propellant was 30 seconds.

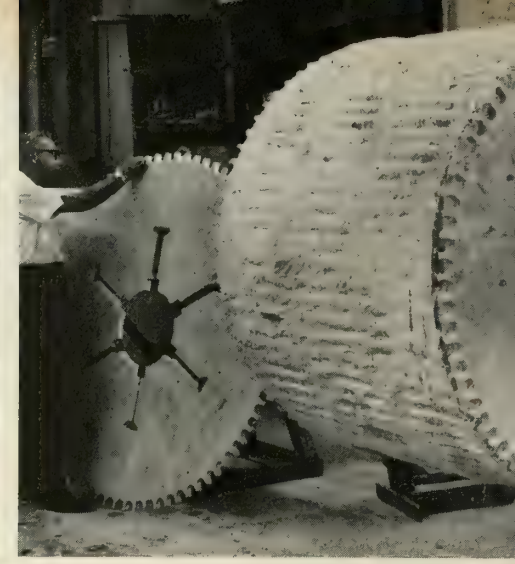
Large Space Chamber Operational

A 27-ft.-long space chamber capable of simulating alti- tudes up to 250 miles and temperatures down to −450°F is in operation at Bendix-Systems Division. The unit is 20 ft. in diameter and has a battery of carbon-arc and infrared lamps behind 16 quarts lenses to simulate solar heat. Bendix engineers checked the facility out by enclosing the whole chamber in a helium envelope, then analyzed the exhaust products from the vacuum pumps for traces of the gas.

ASW & SEABORNE ENGINEERING

Lockheed To Study Whales for ASW Data

Lockheed-California Co. plans to plant a small sonar transmitter on the back of a whale in an effort to obtain data of value to antisubmarine warfare and studies. The miniaturized electronic gear will be planted on the whale's back from a small plane. Signals from the equipment will be tracked by and recorded aboard the Sea Quest, the com- pany's floating marine laboratory.



advanced materials

Lamtex Constructing Biggest Reinforced Case

Experimental 5.5-ft.-dia. filament-wound vessel ordered by Thiokol is major advance

by John F. Judge

FILAMENT-WOUND GLASS cases may ultimately replace the steel chambers in the solid-fueled *Minuteman* ICBM. "It's in the cards" says Dr. Harold W. Ritchey, director of Thiokol Chemical Corp.'s rocket operations.

An experimental, filament-wound pressure vessel 5.5 ft. in diameter and 24 ft. long—approximately the size of a *Minuteman* first-stage engine and the largest reinforced plastic case ever produced—will be fabricated by Lamtex Industries, Inc., under a $320,000-plus contract from Thiokol.

At Lamtex, such large filament-wound cases start with the construction of a break-out plaster mandrel. A steel arbor forms the basic mandrel unit. A series of metal fins are attached to the arbor along its entire length.

Plaster discs are then slid onto the arbor, locking on the fins, and the mandrel begins to take on its final configuration. A number of steel tubes are laid along the outside circumference of

LEFT—*Break-out film and insulation layers are built up on end-closure mandrel before being attached to arbor.*

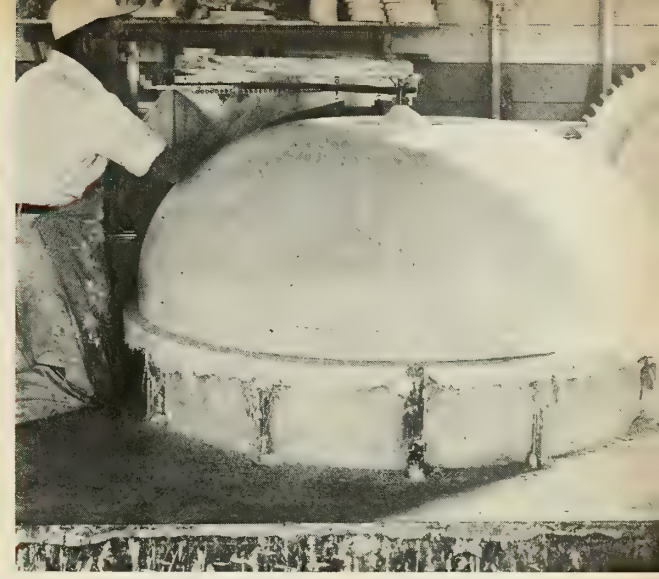
RIGHT—*Fins are attached to massive steel arbor. This core will be used for the large experimental motor case. The plaster break-out mandrel will be built around this in the same manner as the smaller cases illustrated.*

FAR RIGHT—*Mandrel with insulation is ready for the winding operation. The insulation will be cured in the same process used to finish the resin binding the glass fibers.*

FAR LEFT—*Plaster discs are formed around rubber drop-out in the initial mandrel preparation stages. Fluted edges hold reinforcing bars.*

LEFT—*Discs are next set up on steel arbor. Fins welded to arbor fit into the slots in the disc center. Textile-reinforced plaster is then applied.*

RIGHT—*Pressure vessel end closure mandrel section is constructed separately and attached to center mandrel. Surface is smoothed by sweeping final plaster coat.*



the discs and a coating of plaster and textile reinforcing material is applied. The final smooth surface is achieved by sweeping plaster over the entire length of the mandrel.

A strip-out layer of some plastic material is then applied to protect the wound vessel during the plaster break-out. The insulation is added. The two plaster end closure forms, complete with insulation and nozzle fixtures, are fastened to the center mandrel and the unit is ready for the winding operation.

• **Constant tension** — Lamtex uses single-end yarn, consisting of 204 filaments per end. The result is a smooth surface which requires little or no final finishing. The initial winding pattern is helical, and is followed by a reinforcing vertical wind.

The yarn runs from the creels through magnetic tension devices and drop-out mechanisms. The latter afford a measure of control over broken ends of fiber glass.

The winding operation is performed with each filament of fiber glass automatically held under equal tension control—from the creel, through the resin immersion bucket and onto the mandrel. This method prevents progressive glass failure under high stresses.

After winding, the entire unit goes through a multi-stage curing process, involving accurately controlled time and temperature cycles. The glass-resin case and the insulation are cured simultaneously.

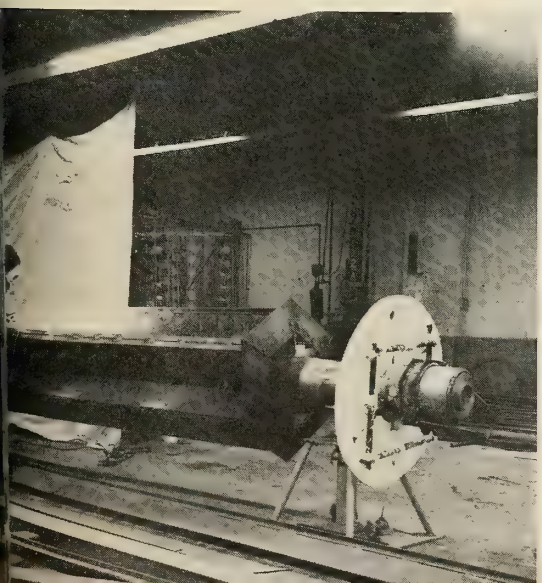
Lamtex engineers design their own filament-winding equipment and are in the process of working up advanced devices. The firm, started in 1955 by three young engineers, moved into a field so new that no standard equipment was commercially available.

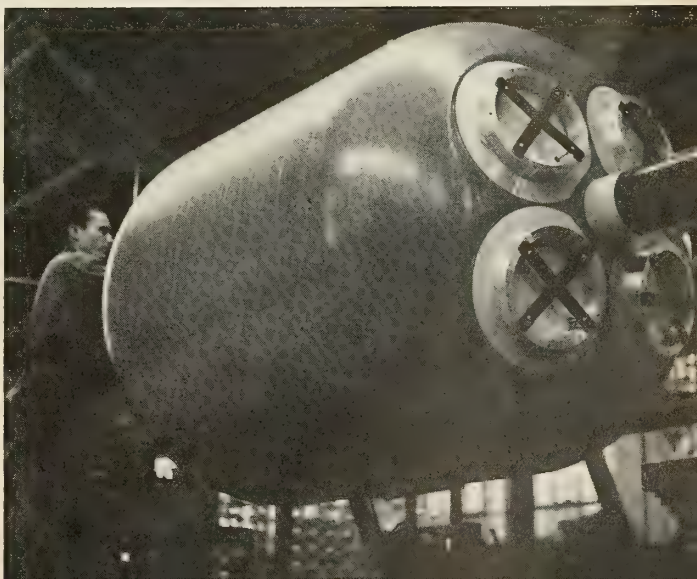
Since that time, Lamtex has pioneered in the design of glass winding and related machines to the extent that some of these have been marketed. A servo-controlled unit is currently being assembled. The firm also has compression and vacuum bag molding facilities.

• **Skipped adolescence** — The biggest problem in the filament-winding area is the quality and consistency of the glass fibers. Filament-winding broke into the missile/space field early in the development phases of both, and W. E. Ponemon, president of Lamtex, says filament-winders have not had time to do adequate research and development.

For the large experimental case, Lamtex is buying a more expensive glass fiber. The higher cost is caused in part by an effort toward uniform qualities.

The potential of glass fibers is greater than that of steel in the pressure vessel area. Both government and industry recognize this, and a host of missile firms are dabbling in filament-winding. But comparatively little is being done to improve the basic glass material. ⁂





LABORATORY LAUNCH PAD

"In-house" missile flights are a daily occurrence at Lockheed Missiles & Space Company. The advantages of "flying" the POLARIS FBM inside the laboratory, on an amazing internally-developed simulator, are obvious.

The simulator performs many developmental and test functions. When the missile is first conceived, performance characteristics are cranked in; basic overall requirements are read out. Later, the simulator details the functional requirements of each subsystem and calculates specifications for hydraulic, electronic and pneumatic hardware. As each component is built, it replaces its computer counterpart.

Finally, the whole guidance and flight control package is put through simulated flights for final checkout. But that isn't all. The simulator also performs the role of post-flight evaluation detective when it is fed tapes of actual flights, and the effects are observed on earth-bound hardware.

It is with such elaborate equipment, guided by engineers and scientists of outstanding calibre, that Lockheed Missiles & Space Company has attained its place in the forefront of missile and space technology. And such progress is constantly creating key positions for other engineers and scientists of proved ability, so they may take up the exciting challenges offered by Lockheed and share in its rewards.

This unusual organization is located in Sunnyvale and Palo Alto, on the San Francisco Peninsula in California. For an informative brochure, "Your Place in Space," write to: Research and Development Staff, Department M-31B, 599 North Mathilda Avenue, Sunnyvale, California. An Equal Opportunity Employer.

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$15-million Test/Evaluation Lab Due

Huge Goddard facility will increase NASA capabilities; industry also building big plants

THE MOST ADVANCED and complete space-test-and-evaluation laboratory in the free world will be operating at NASA's Goddard Space Flight Center within a year.

Costing $15 million for capital structure and equipment, the facility will be a tool for industrial and government scientists.

Companies are also starting to build their own space environmental facilities in order to do a better testing job and at the same time advance into forward competitive positions for space business.

Pacing factors are the larger and more complicated payloads scheduled to be launched within the next three to five years.

• **Full-scale spacecraft tested**—Until its new laboratory is built, Goddard is restricted in its test-and-evaluation work to handling satellites in the 100-lb. payload class and smaller—unless the payloads are broken down into subsystems. The hardship is apparent because it's a rare satellite that weighs less than 100 lbs. For instance, the meteorological satellite *Tiros* weighs nearly 300 lbs.

With its new facility, Goddard will be able to work through test and evaluation any payload that can be launched by an *Atlas-Agena*. This means that the *Orbiting Astronomical Observatory (OAO)*—a 3500-lb. payload—can be handled. (*OAO's* first flight test is scheduled for late 1963 or 1964.) In fact the *OAO* was the module used for the design of Goddard's new facility.

The key facility, and the most expensive, for testing and evaluating spacecraft is a space environment facility. In a finite volume, such a facility tries to duplicate, or simulate, the major phenomena a craft is expected to meet.

Moreover, a complete facility also tries to simulate dynamic flight effects such as acceleration, vibration and spin as well as temperature extremes, vacuum, and radiations brought in by the exotic environment.

Goddard's new test-and-evaluation laboratory is to include two facilities: one for payload testing, and the other for simulating a space environment.

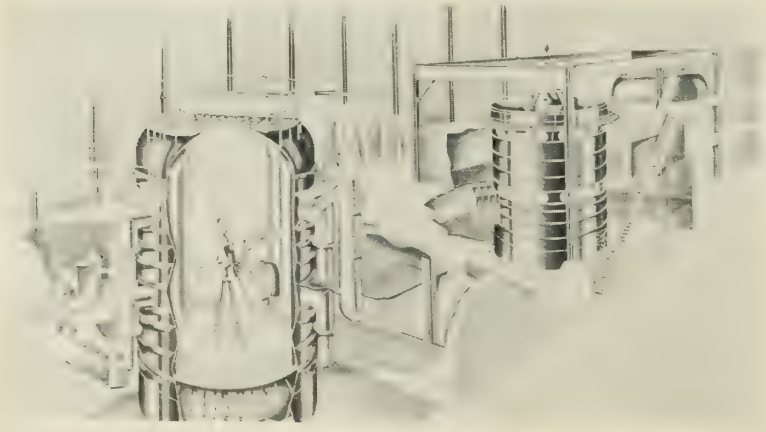
The payload-testing building is to be large—135,000 sq. ft. gross working area. This is a far cry from the interim facility Goddard is now using for the purpose—10,000 sq. ft. It was built in 15 months and occupied in December, 1960. The new payload-testing building will be finished three months from now and operating in July.

A year from now, Goddard will have its space-simulation facility operating—a 40,000-sq.-ft. laboratory able to give final check-out and test to large spacecraft. The facility is needed to make flight-unit acceptance tests on the *Orbiting Geophysical Observatory Nimbus*-class spacecraft as well as the *OAO*.

Other NASA establishments also have or are building facilities to test spacecraft. Chief among these are Jet Propulsion Laboratory (JPL), Langley Research Center and Marshall Space Flight Center. Each, including Goddard, has unique testing facilities as well as capabilities in five major areas: mechanically induced forces, humidity and vacuum, fields and combined environments.

Goddard's new plant is specifically designed to check out scientific satellites, probes and payloads that will be launched within the next three to five years. It will be large enough to handle three big models at the same time: one *Atlas-Agena* payload plus two *Thor-Deltas*. In other words, it will be able to take care of simultaneously one 4000-lb. payload plus two 1000-pounders.

The Center's payload-testing facility will emphasize subsystem testing and evaluation of contractor products, while the simulator facility will concentrate on complete system testing. Payload testing includes simulating the extremes of the natural and induced environmental forces which a space vehicle will experience in its life cycle of ground-handling, launch, flight, re-entry and landing.



ARTIST'S CONCEPTION of projected space environment facility shows dynamic test chamber and space simulator chamber.

n Year

by William Beller

John C. New, chief of Goddard's test and evaluation division, says he prefers that contractors do their own testing and evaluation, if they have the facilities. This would take a load off Goddard's crowded laboratory schedule. He further notes that if a contractor has adequate facilities for test, it will add cubits to his stature when it comes to contract awards.

Goddard's space environment facility is made up of two pieces of major equipment, identical in shape but different in purpose: the dynamic test chamber and the space-environment simulator.

Both will be able to handle spacecraft whose diameter plus extensions such as solar panels and antenna span up to 25 ft.

The dynamic test chamber is to be used for testing spacecraft performance that is affected by air resistance. Made of stainless steel, the chamber provides a vacuum vessel 27 ft. in diameter, 40 ft. high. Mechanical pumps will drive the pressure down to 0.1 mm of mercury, sufficiently low for the dynamic tests to be run.

Examples of some chamber tests are dynamic balancing, spin-up and solar-paddle erection. Another type of testing to be conducted is checking out control systems which use gas jets to orient spacecraft. Such tests require reduced pressure to cut down air drag and for proper simulation of the environment in which the jets operate.

Spacecraft are placed in the chamber through its top, which is moved off by a special crane. Since the chamber would be contaminated by the gases ejected by jet nozzles, it is not used for other than dynamic work.

To approach the conditions of outer space, the space-environment simulator is to be used. Here, the stresses of the environment of space are imposed on a spacecraft to see how well it functions, or to bring it to failure.

Pressure is depressed by mechanical blowers, diffusion pumps and cryogenic walls. The bulk of the air is taken out by the mechanical blowers; diffusion pumps continue the process; finally, cryogenic panels in which liquid nitrogen is circulated freeze out most of the remaining molecules. In full operation, the system is expected to go down to 1×10^{-7} mm of mercury.

Chief parameters used in the chamber tests will be vacuum effects, solar radiation and thermal gradients. The last will be varied by changing the curtain-wall temperatures, which will be variable from $-65°C$ to $100°C$.

Until recently, there were no chambers in prospect to test complete satellites under simulated space conditions. Now, besides Goddard's, at least three major ones are under construction.

JPL is putting up a $4.5-million chamber to test lunar and interplanetary probes, such as the 450-lb. *Mariner* scheduled for a Venus fly-by August, 1962. Similar in operation to Goddard's simulator, the JPL chamber has a working volume 25 ft. in diameter, 35 ft. long. (Goddard's working volume is 27 ft. in diameter, 40 ft. high.)

Lockheed is building an eight-story high, $3.5-million environmental chamber planned to check out earth-orbiting satellites. General Electric is financing a $6-million chamber originally designed to test communications satellites, but also able to test through heat, cold and vacuum conditions, manned spacecraft, space suits, and interplanetary probes.

• **Goddard test programs**—To be reasonably sure that a spacecraft will operate satisfactorily after launch, Goddard scientists call for tests of a prototype at levels exceeding the expected environment, and tests of the flight units under the expected environmental conditions.

For this reason, John New says that test programs must:

1) Verify that novel and unproven designs meet performance requirements and have satisfactory life expectancy under pre-launch, launch and space environment conditions.

2) Determine the ability of available hardware, proven for non-space applications, to withstand the launch and space environment.

3) Locate defects in material and workmanship.

4) Generate knowledge for assessing reliability and providing a basis for future designs.

Reduced to practice, the Goddard testing program usually calls for five spacecraft units. This first is an engineering model, used to determine static characteristics such as weight and weight distribution, and volumes available for subsystem placement. Often this model is made of wood.

The second is the structural model, made of the engineering materials the flight model will use. Besides giving the spacecraft's dynamic characteristics, such as moments of inertia, this model is used to determine the spacecraft's structural strength. This is an essential investigation because improper placement of subsystem payloads may give rise to critical stress concentrations.

The third model is the prototype design—the first complete operating system. It is tested at 1.5 times the expected flight level.

Usually, two identical flight units are made, one for a backup. These are tested at expected flight levels of stress.

New affirmed that "we have never had a satellite failure in a unit that has gone through our tests." He added that, "We have had one sounding rocket payload that went through our tests and later failed . . . because we tested it wrong. We had not duplicated the conditions that were met."

He emphasized that in test and evaluation, the environmental conditions must be at the very least simulated but, far better, duplicated.

New estimated that a complete prototype qualification program for testing a satellite spacecraft may take two months if no major problems are met. Typically, an extra month should be allowed in program planning.

About six weeks are needed for flight-unit testing. However, two months more should be allowed in program planning to take care of any exceptional conditions met. In spacecraft work, meeting the unexpected seems to be the rule.

Test and evaluation is at the tail end of the spacecraft developmental program. As a result, it is squeezed on one side by scientists eager to provide a completed payload, and on the other by the scheduled launch date.

At the same time, test-and-evaluation techniques must make the probability of success as high as possible. To do all this on a shortened time scale, extensive test facilities are being built at Goddard; they will be monitored by scientists who will be able to make quick decisions based on data coming out of a programed computer.

Turn to p. 28 for a list of typical NASA test facilities.

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Static

LANGLEY RESEARCH CENTER: *Structural and materials testing with reaction capabilities up to 10^6-lb. force.*

GODDARD SPACE FLIGHT CENTER: *Structural testing, 500,000-lb. force*

Dynamic

MARSHALL SPACE FLIGHT CENTER: *Centrifuge, 500-lb. capacity (will accept 5-ft. cube), 8 ft. radius, 100-g acceleration limit*

GODDARD: *Centrifuge, 700-lb. capacity (will accept right circular cylinder 4-ft.-dia. by 4-ft.-long), 10-ft. radius, 50-g acceleration limit*

MARSHALL SPACE FLIGHT CENTER: *Rocket sled, 35-g maximum for about 0.5 sec., 100-lb. payload*

GODDARD: *Acoustic Reverberant Chamber, 440 cu.. ft., 160 ± db., 30 cps to 10,000 cps (in operation 1962)*

FIELDS

LANGLEY: *Antenna design and test facilities including special hot jet for testing effects of ionized gases on antennas*

MARSHALL: *Magnetic field apparatus, 0-150 gauss, working space about 4-ft.-inside-dia. by 4-ft.-long*

COMBINED ENVIRONMENTS

JET PROPULSION LABORATORY: *Thermal-Vacuum Chamber, 25-ft. dia. x 35-ft. long, 10^{-6}mm Hg, solar simulation, cryopanels (in operation early 1962)*

GODDARD: *Space Simulator, 27-ft. dia. x 40-ft.-high work space, 10^{-8}mm Hg empty, solar simulation, cryopanels (in operation late 1962)*

GODDARD: *Dynamic Test Chamber, 27-ft.-dia. x 40-ft.-high work space, 0.1 mm Hg, spin and de-spin tests, air jet tests, dynamic balancing (in operation late 1962)*

GODDARD: *Thermal-Vacuum Chamber, 8-ft.-dia. x 8-ft.-long, 10^{-7}mm Hg empty, —65°C to 100°C*

GODDARD: *Thermal-Vacuum Chamber, 12-ft.-dia. x 15-ft.-high, 10^{-5}mm Hg empty, solar simulation, cryopanels (in operation 1962)*

LANGLEY: *Combined spin and de-spin apparatus in vacuum*

LANGLEY: *High-Thermal-Vacuum Chamber, 200 cu. ft., 10^{-4}mm Hg, (includes hot and cold wall capability for simulating free-space conditions)*

MARSHALL AND LANGLEY: *High-temperature, quartz-tube radiant heaters for structural temeprature tests*

MARSHALL: *Thermal-Vacuum Chamber, 4-ft.-dia. x 6-ft.-long, 10^{-6}mm Hg, internal liquid nitrogen coils*

MARSHALL: *Thermal-Vacuum Chamber, 12-ft.-dia. by 64-ft.-long, 8 mm Hg, internal steam pipes*

He's solving a real estate problem

This AMF engineer's job is determining how best to move big missiles off shore for launching. Should they be floated out horizontally, flooded to an upright position, and then launched? Or, would it be more feasible to barge them out? Might they be moved to or assembled on "Texas Towers," or would a causeway or simply land-fill be the answer?

Behind the project is our shrinking real estate at launching sites, plus the hazards inherent in launching Saturn-sized missiles (and the coming, nuclear-powered missiles) near other installations. Off-shore launching may be the answer.

Feasibility studies of all types are an AMF specialty. What kind of remotely controlled machinery is required to service nuclear-powered aircraft? What kind of habitation could be built on (or under) the surface of the moon? What sort of machines (manned and unmanned) could survey the moon's surface without, for example, falling into a fissure? What is the best way to assemble a space station? All these are problems AMF engineers are presently investigating.

If your problem is the first of its kind, AMF will not, of course, have met it before. But AMF's long experience in accepting totally unique challenges gives it an advantage enjoyed by few other organizations concerned with ground support, launchability and space environment. To get further information write American Machine & Foundry Company, 261 Madison Avenue, New York 16, N. Y.

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'Jeep of the Deep' Nears First U.S.

Loral Electronics opens new Florida test facility; one- and two-man vehicles have clear military merit

THE "JEEP of the deep," a one-man submersible being marketed by Loral Electronics Corp. of New York, will be put through its initial U.S. sea trials next month.

Representatives of several Navy and civilian oceanographic agencies have been invited to attend the demonstration at Loral's new maintenance and test facility in Ft. Lauderdale, Fla.

The undersea craft, officially designated the T-14, is the first in a line of subsurface vehicles to come out of the company's newly established Underwater Technology and Oceanography Division.

Loral, a long-term ASW contributer, moved into the oceanography business last July when it imported the services of Dr. Dimitri Rebikoff, well-known French undersea explorer, inventor, and photographer. Rebikoff, the developer of the T-14, is currently technical director of the new division.

Along with Rebikoff have come the North American patent rights and considerable existing hardware for a string of one- and two-man underwater vehicles and associated navigation and photographic equipment.

• **Dual role** — Though billed primarily as oceanographic vessels, these small and highly maneuverable craft have several obvious military capabilities, both offensive and defensive.

Loral, in purchasing Rebikoff's inventions and services, plans to make this equipment available to various Navy and civilian agencies reportedly interested but reluctant to spend dollars abroad for these items. Much of the equipment developed by Rebikoff is either in service or under evaluation with the British, West German, French, Japanese, and Yugoslav navies.

The T-14 is the basic vehicle to be marketed by Loral. It will cost about $15,000 per unit in small quantities.

The T-14 is a torpedo-shaped submersible reportedly capable of driving a SCUBA (self-contained underwater breathing apparatus)-equipped diver around at 3.5 knots at depths to 230 ft. for about two hours.

The diver straddles the vehicle and controls its movements through a system similar in concept to an aircraft's control network. The aileron and rudder controls, operated with both hands and feet, provide complete operator control in yaw, pitch, and roll; and also allows the craft a turning radius within its own length. The forward diving rudders are spring-loaded to retract upon contact with an underwater obstacle and then return to normal extended position.

A 1.5-hp electric motor geared to an 11.5-in.-dia. three-blade propeller supplies the propulsion for the T-14. Company officials claim a 90% efficiency ratio for the propeller through use of a Kort-nozzle, a propeller-shroud combination which creates a water-jet reaction.

Power for the propulsion unit and also for the underwater navigation system, camera, and lights is supplied by a single 24-volt, 18-celled (silver-zinc) battery which occupies most of the forward hull section. Battery capacity is listed as 100 amps, which translates roughly to two hours of continuous operation for the T-14 configuration.

The T-14 is constructed of lightweight aluminum, weighs about 180 lbs. fully equipped, is 9½ ft. long and 4 ft. wide with rudders extended. About a dozen of these are on hand at the company.

• **Can tow 1000 lbs.**—Loral also claims that the T-14 is capable of towing a properly configured 1000-lb. payload which greatly increase the number and types of craft utilization. No additional power is needed for the towing operation.

Standard mounted and packaged equipment aboard the T-14 includes a T-18 instrument and navigation pod, a T-23 cinemarine motion picture camera, and a pair of photoflood lights.

Included in the 27-lb. T-18 package is a directional gyro, attitude indicator, depth meter, chronometer, voltmeter, and water-leak detectors for both the vehicle and the pods.

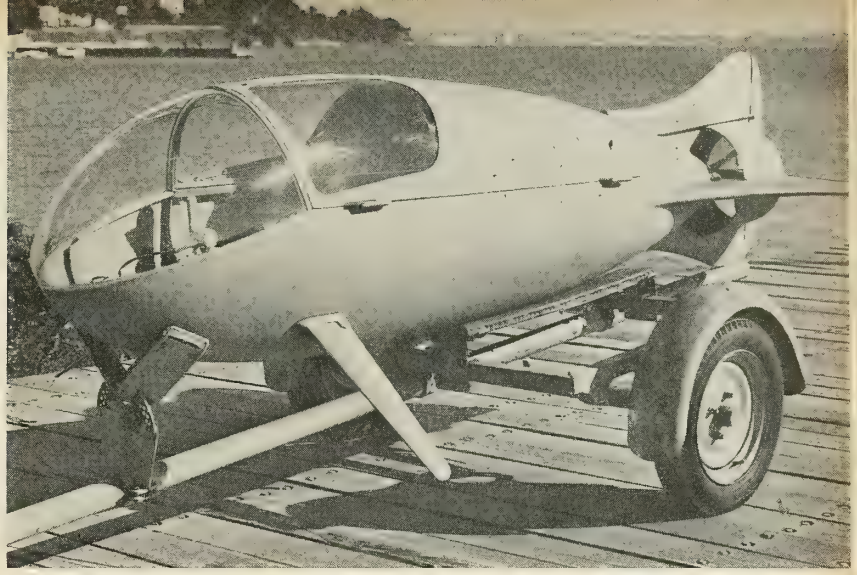
The T-23 camera is fully automatic, with a 200-ft. film capacity. The combination lens system, co-developed by Rebikoff, includes an f2.0 10mm wide-angle Retrofocus Angenieux photographic lens, and a correction lens to compensate for plane diopter distortion due to light refraction between air and water.

In an effort to project the T-14 into as many undersea roles as possible, Loral is also developing the following modified versions:

PR-25—This is a free-flooding one-

Sea Trials

by Michael Getler



ONE-MAN VERSION of the T-14 shown on its trailer. The manufacturers report that the 180-lb. vehicle can tow a 1000-lb. payload with no added power.

man enclosed version of the T-14 capable of speeds between 7 and 10 knots. Slightly larger and heavier than the T-14, this craft has additional speed achieved through the streamlined hydrodynamic shape which encloses the diver. A prototype of this craft has been built and tested.

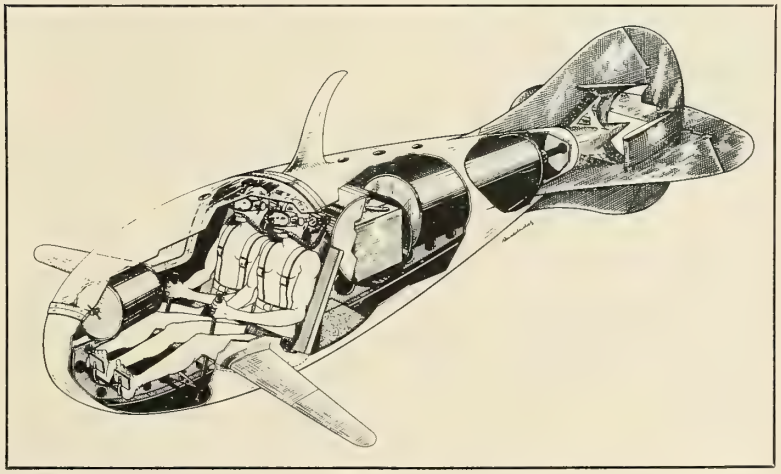
PR-29—The same T-14—with a cable attachment to a surface power generator for extended duration on search or station.

PR-32—Again, the same T-14 but without the rider. The vehicle is remotely controlled through an electro-hydraulic system.

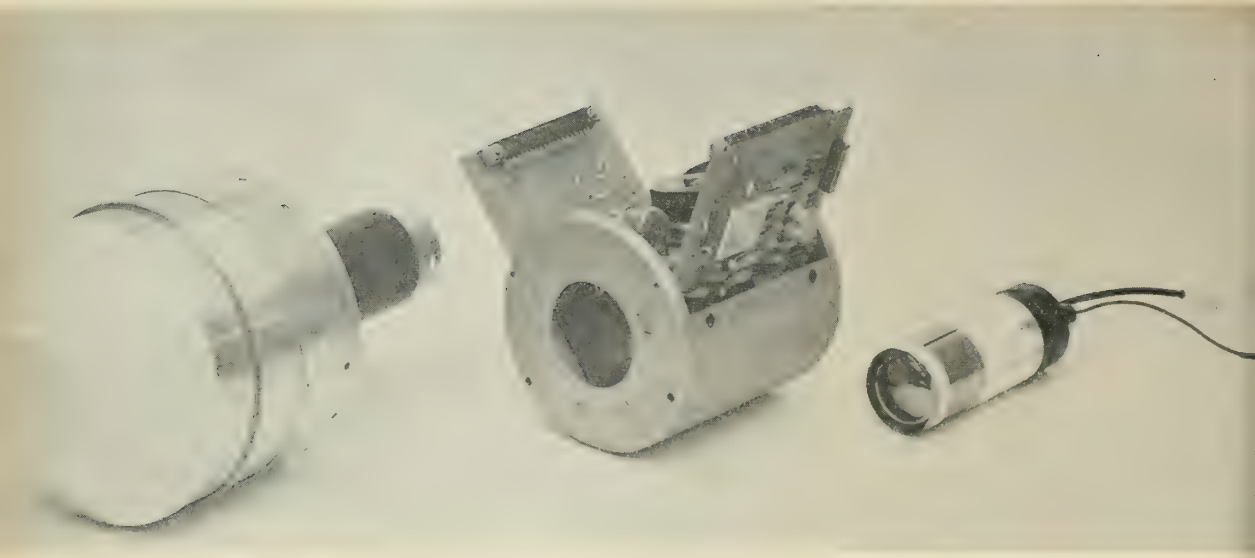
Design has also been completed for a two-man, pilot and observer version for which Loral has high hopes. Speed of this unit is expected to approach 12 knots.

Loral's basic pitch in marketing these vehicles will be the considerable extension of current underwater capabilities for the military or civilian diver through use of the T-14. Dr. Rebikoff estimates underwater speed, range, endurance, and work load could be increased by a factor of ten with these vehicles.

Also, to provide additional support for Rebikoff and his staff, the company again reached into the European market and acquired the consulting services of another well-known pioneer undersea explorer, Jacques Piccard. Among other adventures, Piccard was co-pilot of the bathyscaphe "Trieste" which descended 35,800 ft. to the floor of the Pacific in 1960. ⌗



ABOVE: *Artist's drawing of two-man vehicle, in which Navy is greatly interested. INVENTOR OF T-14 is Dr. Dimitri Rebikoff, famed underwater explorer-photographer.*



MISS-DISTANCE Indicator A/A24D-5(XI-3) weighs 10 lbs., consists of (left to right) 7-in. plastic scintillator, transistorized detector electronics, 2-in.-dia. multiplier phototube.

missile electronics

A Gamma-Ray Miss-Distance Indicator

All three services greatly interested in device made by Franklin Systems; high accuracy and lower cost

by Charles D. LaFond

THE AIR FORCE is making final tests of a simple, accurate and lightweight missile miss-distance indicator that uses gamma-ray detection instead of electromagnetic energy.

The device represents the first significant breakthrough in the military's long search for a universal scoring system.

At a cost approaching $100 million, the three services have sought such a system for 15 years. A host of R&D contracts have been awarded, yet only two operational systems are in real operational use today.

It now appears that an investment of less than $400,000 has yielded an approach that not only works but can be used with munitions ranging from 20-mm size to *Nike-Zeus* or bigger.

Developed by Franklin Systems, Inc., of West Palm Beach, Fla., the technique employs a gamma-ray source and a detection device to form a cooperative scoring system between target and missile.

Two systems actually have been developed: one employs its own flight computer and transmits hit-or-miss information to the ground; the other requires a ground computer and provides scalar miss-distance measurements. With modification, the latter system can also provide relative velocity data.

The Air Force is just winding up tests of the latest models at Eglin AFB; the Army has purchased a small lot of the devices for testing at Aberdeen Proving Ground and at White Sands Missile Range; the Navy will buy units shortly to perform its own tests.

The intense interest in the systems is based largely on three features: they avoid the use of radio frequencies, they are very accurate, and they are relatively small and inexpensive.

• **Past problems** — Most early approaches to munitions scoring involved the use of electromagnetic systems using the short components of a radiative field. In essence they transmitted signals and collected reflections.

Doppler systems—using both short and long pulses—came next. They employed strong output signals and worked with very weak return signals.

The big advantage of such systems is that they are non-cooperative. However, they have been snarled in feedback problems and high switching transients.

The two systems now in operational use in the U.S. are the Parami, developed by Ralph M. Parsons Co., and MATTS (Multiple Airborne Target Trajectory System) developed by Cubic Corp.

The Parsons' approach uses a continuous pulse train r-f transmission and employs a large transponder in the flight vehicle. It is considered by many to be the best available—but its use is limited to large munitions.

The Cubic system employs radar techniques and is very accurate. However, it requires a considerable amount of flight hardware and a well-instrumented range for support.

Other approaches which have been attempted in the past but so far have proved unsatisfactory include:

—Infrared detection and measurements of projectile thermal radiation.

—Accoustical measurement of projectile shock waves.

—Electrostatic measurements of charges in front of projectiles.

—Optical sensing.

—Photographic measurement of projectile traces.

The gamma-ray cooperative system so far appears to be the best of the new approaches. Franklin has worked on its systems for over five years and has been

working on a series of Air Force development contracts for over three years.

Recently, M/R has learned, Aerospace Corp. has awarded a development contract to General Electric Co. for a scorer to be used in the *Nike-Zeus* target missiles. They, too, will use the gamma ray measurement approach.

• **Scoring method**—The use of a gamma-ray emitter for missile or other projectile scoring simply involves the determination of count-rate signal in pulses/min. over the background level at a particular altitude.

A munition tagged with a gamma-ray label of specific millicurie strength will cause a signal peak at minimum distance of approach to a target, then a steady decrease. Scorer sensitivity and gamma-ray source strength determine the threshold hit-distance.

Tagged munitions passing a target at constant relative velocity but at various miss-distances will generate a family of curves whose heights are proportional to miss-distance (plotting pulse count/min. against time). Curve width (time) varies considerably in another family of curves generated by an emitting munition having a fixed miss-distance but approaching a scorer at different relative velocities. Apex of all curves in the latter are approximately coincident.

The FSI scoring system employs a threshold detector having a fast and a slow integrator circuit to analyze signals produced by a passing projectile.

Thus a decreased time constant in the first circuit makes the scorer more nearly peak-reading and less velocity-dependent in the range of interest.

Conversely, by increasing the time constant in the slow circuit, it can be used to measure projectile velocity up to some fixed limit.

The first circuit measures miss-distance independently of velocity; the second reduces the effect of spurious signals.

By fixing upper and lower limits of the slow integrator for rejection, the scorer is adjusted for operation with different types of munitions.

Both fast and slow circuits must register before a "hit" is indicated.

For miss-distance measurements, a ground computer is employed. To obtain relative velocity, a pair of flight units is used to feed trajectory data to the ground station.

• **Scorer and MDI** — Development of both the Franklin Proximity Scorer, A/A24D-5(XI-2), and Miss-Distance Indicator, A/A24-D5(XI-3), has been the result of over five years of work. The first contract was begun in June, 1958.

The XI-2 is designed to register "hits" only and reject spurious emissions and near-misses. The system consists basically of three component groups: a gamma-ray tag or label on the munition fired, a detector/scorer and telemetry system in the target, and ground receiving and recording electronics.

Developed under an Air Force contract for Detachment 4 of Air Force Systems Command, located at the USAF Target Development Laboratory, Eglin AFB, the scorer has been undergoing continual design improvement and extensive test and evaluation since early 1960.

Hit-threshold ranges of 15- or 30-ft. spherical radius are standard, although other miss-distances can be obtained.

The scorer package weighs 13.5 lbs., or 21 lbs. with its lead-acid rechargeable batteries, and measures 14.5-in. x 7.25-in.-dia. overall. Effective system volume is 400 cu. in. plus another 62 cu. in. for the power supply. Minimum telemetering equipment occupies another 18-20 cu. in. Power requirements are 18-22 volts at 0.6 amps. (average) or 1.5 amp peak.

The gamma-ray detector is a 7-in.-dia., spherical-coverage scintillator employing plastic phosphor of activated polyvinyltoluene. Munition tags are ring- or cap-type and source strength (0.6 millicurie of zinc 65 for 15-ft. range) can be varied to determine scorer range.

Franklin uses a Bendix TXV-13 transmitter for telemetering data to ground. It operates on a frequency of 234.0 mc. Power requirements are 2 watts, to provide a range of over 60 miles at 35,000 ft. A variety of antennas could be used, but Franklin has found a horizontal half-wave dipole to be satisfactory.

System tests at the Eglin firing range so far have used 20-mm rounds and 5-in. HVAR's. Scorers were installed in *OQ-19* target drones, and MC-3 and MC-5 tow targets.

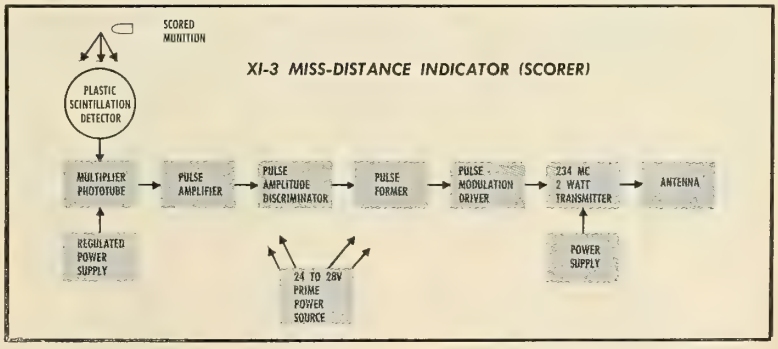
The XI-3 MDI circuitry is functionally similar to its predecessor, the XI-2, but is considerably simplified. Also transistorized, it weighs 10 lbs. without power supply and occupies 265 cu. in.

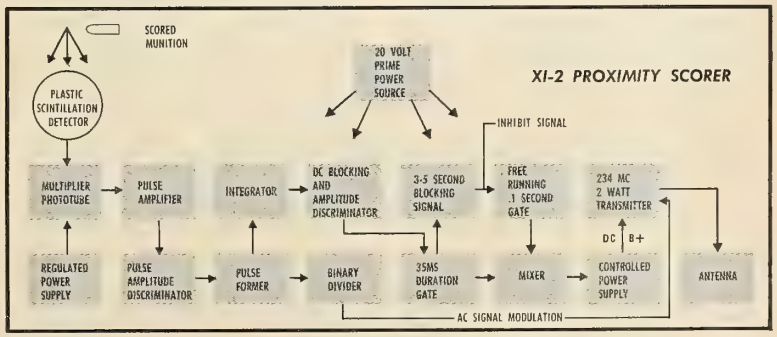
Standard ranges are from 5 to 50 ft. and can be extended readily anywhere in the range of from 1 to 1000 ft., the company reports. Nominal accuracy is 10% of actual range. All scoring is performed at the ground stations.

The MDI requires 24 to 28v at 1.6 amp. and uses either a 7 or 5½ in. dia. scintillator for gamma-ray detection.

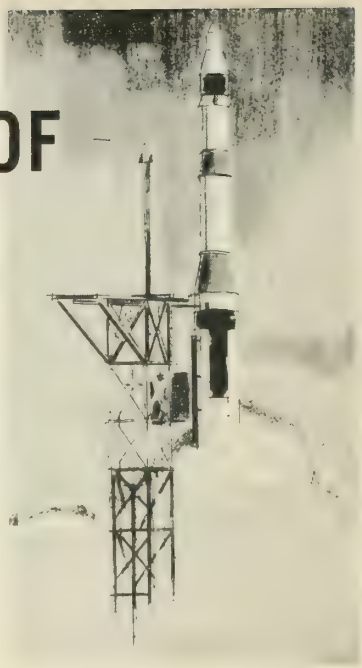
A Bendix TXV-22, 2-watt transmitter is used for telemetering. Frequency used is 234.0 mc and range also is over 60 miles at 35,000-ft. altitude with a dipole antenna.

With modification, FSI president Henry C. Gibson, Jr., states that the system could be employed as an anti-ballistic missile miss-distance scorer or





SWEET SOUND OF SUCCESS



Each time the mighty Minuteman roars through a static or flight test, Allison gains new stature as a major source of steel cases for large, solid propellant rocket engines. First and second stage cases for Minuteman, designed and built by Allison under contract to Thiokol and Aerojet-General, continue to achieve an impressive 100% reliability record.

Expanding work in this area now involves not only steel, but titanium and glass filament wound cases as well. In this connection, a numerical analog control glass filament winding machine, designed and built by Allison, has proved to be one of the most versatile machines of its type in the nation.

Looking ahead, this successful program indicates applications with Nova, Satan, Scout, Saturn C-3 and C-4, MRBM, and advanced types of Minuteman and Polaris.

Other major achievements in rocketry research include development of improved high-temperature, solid-propellant rocket nozzles; solid and liquid propellant reaction systems for control of attitude and velocity of ballistic missiles and space vehicles, and a number of inventions relating to unique propulsion systems.

Further expansion and development of these and similar programs has created immediate opportunities for men with experience and advanced degrees to share in Allison's success. Specifically, we have openings—now—for the following people:

SYSTEMS ANALYSTS—(MS or PhD in applied mathematics) should have at least 4 years experience in analytical solution of physical phenomena, represented by differential equations of all types. Engineering analysis of hot gas dynamics, combustion, interior ballistics and grain design, structural design, control system synthesis, missile dynamics and overall systems performance.

SYSTEMS ANALYSTS—(MS) with minimum of 4 years experience in field of engineering and mathematics. Trade-off studies for rocket engine systems and components and provide planning information.

ENGINEERS—(BS or MS) with 4-5 years experience in gas dynamics and nozzle mechanics design. Design and analysis of nozzles for solid propellant rocket engines; conceptual design of advanced nozzles, including regeneration and sublimation cooling.

DESIGN or MECHANICAL ENGINEERS—3-5 years background in plastic case design and development, plus sound design and structures background. Design and analysis of plastic pressure vessels.

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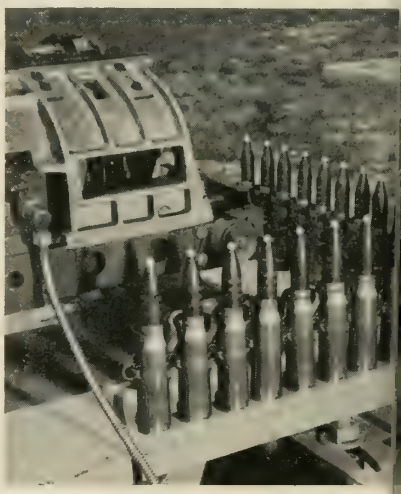
indicator. Closing velocities up to 40,000 ft./sec. in outer space could be handled by the MDI, he said.

• **Gamma-ray tags** — The radioactive tags generally are first drawn from a desired base metal. After fabrication, they are sent to a reactor for neutron irradiation.

To avoid contamination in handling, tags are often plated with a very short half-life metal such as gold or copper. By the time the tags are used, the plating is non-radioactive.

When ready for use, tags are attached to munitions with special tools and a high-tack cement. Tools used assure that the radiation exposure level for handling personnel remains at least an order of magnitude below maximum permissible levels.

Franklin cites the example that one would have to remain for 1 minute at a distance of three feet from a pile of 7500 typical tags to take a chest X-ray. Tests also have shown that flight personnel are subjected to almost no additional exposure compared to normal cosmic ray background.



20-MM ROUNDS are tagged with radioactive labels. Emitter intensity and scorer sensitivity determine hit distance.

Handling procedures have been approved by the Atomic Energy Commission; however, AEC licenses must be issued for personnel and mission areas.

Two independently performed studies of the possible hazards involved in the sea-water disposal of tags have been made for Franklin. Both Dr. Fritz F. Koczy, head of the physical science division of Miami University's Marine Laboratory in Florida, and Dr. Dayton E. Carritt, assistant director of Chesapeake Bay Institute, Johns Hopkins University, concluded in their reports that the radiation effects of one million tagged 20-mm shells (using zinc 65)

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deposited in one year in off-shore waters would be well within the bounds of safety.

• **Air-to-air MDI**—Using a modified XI-3 Miss-Distance Indicator system, Franklin has now developed a method for determining target miss-distance and relative velocities up to 20,000 ft./sec. for air-to-air missiles.

Distances from 0 to 100 ft. or more can be measured and read out on the ground in real time with reasonable accuracy. By taping outputs and using a computer, both velocity and distance can be obtained with higher accuracy, developers say.

Also, for those situations where ionized layers exist about the target, a radioactive source installed on the target will permit a quantitative, instantaneous, cooperative measurement.

The approach consists essentially of the use of a gamma-ray emission from the target and a sensitive detection/transmission system from the missile. A pulse or analog signal is transmitted through a telemetering system to a ground station and the output data are recorded. Both a wide band magnetic tape recording and a graphic display (for real-time presentation) are made.

This modified XI-3 system uses a rugged 2-in.-dia. multiplier phototube—an ASCOP model 541A or 543A, a fast transistorized pulse amplifier, discriminator, and pulse divider with pulse-pair resolution of 5×10^{-8} sec.

FSI engineers assert that the equipment configuration will permit rapid pulse counting without signal pile-up to within a few feet of miss-distance. Measure of miss distance to zero range can be obtained with an analog output (for count rates to 10^{10} pulses/sec.).

Data are telemetered to ground using the 50-100 kc bandwidth capability of a standard link.

Miss-distance accuracy to 10 ft. ± 5% at 15,000 ft./sec. relative velocity is obtainable, developers say, by using roughly 56 millicuries of radio zinc 65 or antimony 124. The zinc has a 260-day half life, antimony 60 days.

Other typical values based on gamma-ray source strength as calculated by FSI are shown in the accompanying table.

Relationship of Miss-Distance Measurement Variables (Typical Values)

Source Strength (millicuries)	MDI Accuracy* (%)	Scalar Distance (feet)	Relative Velocity (feet)
186	±10	100	20,000
560	±10	40	15,000
560	±20	160	15,000
704	± 5	100	20,000
704	±10	200	10,000

For a given source strength, the square of the accuracy percentage varies:

(1) directly as the scalar miss-distance, with a constant relative velocity; or

(2) inversely as the relative velocity, with a constant scalar miss-distance

Complete indicator circuitry also re-

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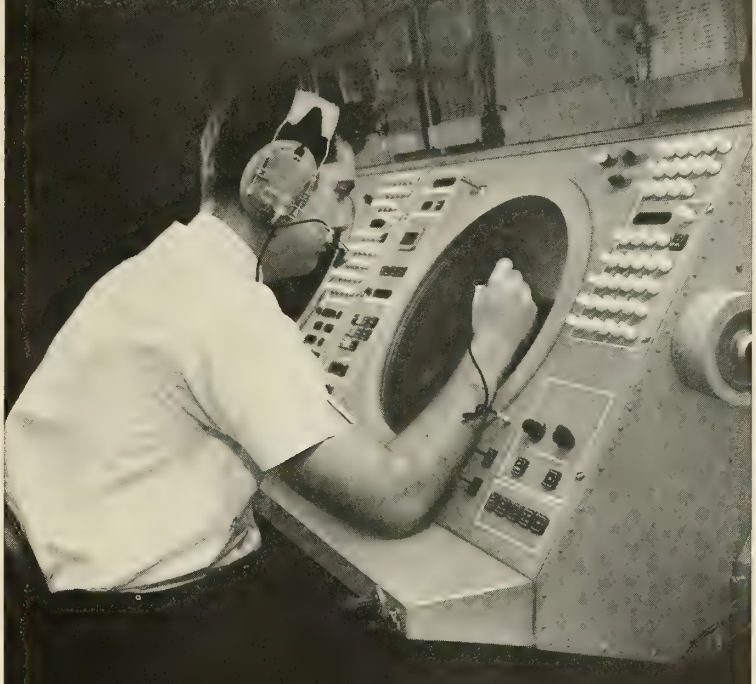

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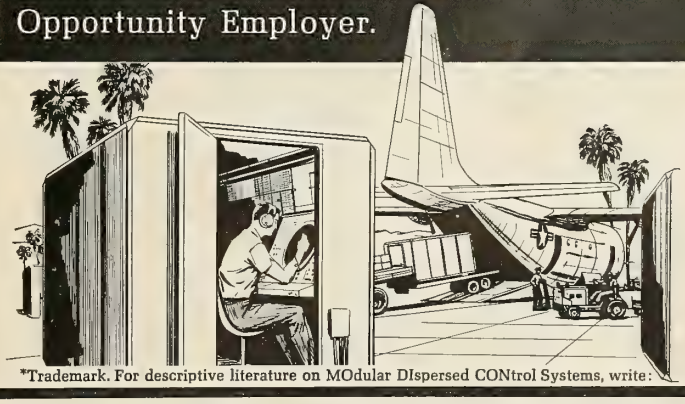

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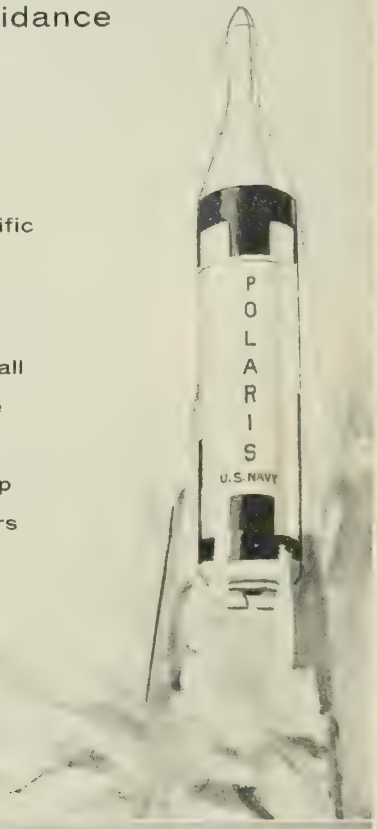

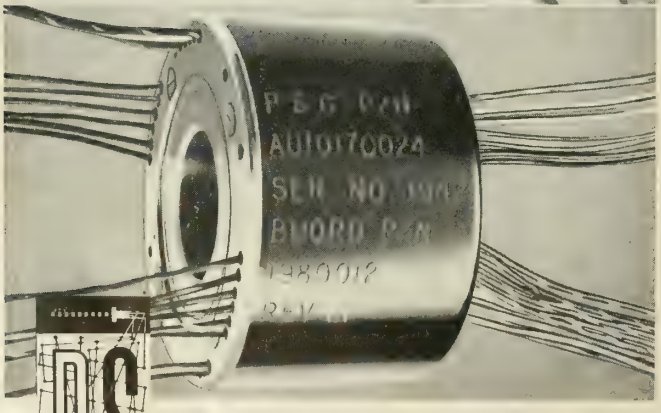

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quires a telemetry modulator and transmitter.

Even with a fine resolution obtainable in the pulse circuitry, there is a 10% count rate loss at 10^6 counts/sec. For a rate to 10^{10} counts/sec., an analog peak signal channel instead of pulse counting would give a 1% accuracy, limited only by the telemetry bandwidth channel. Readout is by an analog output through a 1-mc bandwidth amplifier.

Actual count rate is transmitted digitally, and will vary from the typical background rate of about 200 to 400 counts/sec. to a peak rate of 10^7/sec.

Scaling factors of 2, 4, 8 and 16 are used. Also, an integrated analog signal from 10^7 to 10^{10} cps can be transmitted to permit a large dynamic range of miss-distance indication.

• **Many advantages** — Franklin engineers claim many distinct advantages in the use of gamma rays for scoring and miss-distance indication as opposed to conventional radio frequency or optical systems.

A principal advantage is that the approach creates no interference with communication or telemetry systems in the vicinity—or for that matter with any other nonnuclear electronic equipment. Conversely, radiations are nonjammable by other electronic equipment.

The radiating material is a passive emitter requiring no external power supply. Also, since the material required is so small, it can be attached to the smallest munitions without altering aerodynamic or ballistic properties.

Other advantages claimed:

—Independence of the radiosotope gamma-ray source from ordinary environmental influences such as temperature and pressure.

—Source life can be predetermined by the selection of various radioisotopes. Decay strength can range from hours to years, depending only on the requirement.

—Finally, the radiation is non-detectable beyond design range.

Franklin's president Gibson told M/R that production quantities of its XI-3 system (without telemetry or power supplies) should lower the unit price to about $800. Experimental quantities now are available at from $2000 to $3000 each.

Systems modified for ranges out to 1000 ft. and capable of indicated miss distance and relative velocity might run to $25,000 per installation.

It is understood that the Franklin system is being considered for use with several other missiles. ⌘

Circle No. 10 on Subscriber Service Card

New Product of the Week:
Preventive Maintenance Tape Tester

Three data processing products designed as a complete preventative maintenance system for magnetic tape are available from General Kinetics Inc.

The three products are the Model Seven Tape Tester, the Model CT-2 KINESONIC Tape Cleaner and the Model WT-183 Programed Tension Tape Winder.

The Model Seven Tape Tester makes both signal and noise tests (in one pass) to determine existing and potential trouble spots. Defects due to dropouts, noise pulses and time-displacement errors are detected and recorded.

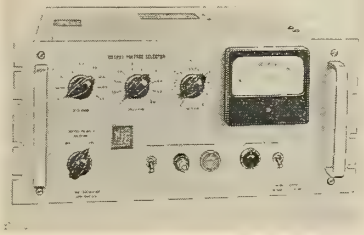
The Model CT-2 KINESONIC Tape Cleaner reduces computer stoppages due to tape errors caused by loose oxide, tape-base chips and common dirt contaminations which collect on the tape and which may deposit on the magnetic reading and writing heads. The GKI tape cleaner reduces computer lost time while extending tape life.

The Model WT-183 Programed Tension Tape Winder produces smooth, stable rolls by programing the winding tension (through the use of tension control cams) to optimize each particular combination of tape material and reel type. Off-line winding of tape on the WT-183 aids trouble-free storage and minimizes the effects of humidity and temperature change as well as those of shock and vibration during shipment.

Circle No. 225 on Subscriber Service Card

D-C Power Amplifier

Inertronics, Inc., is marketing a d-c power amplifier for use in driving d-c torquemotors of 3W to 100W capacity from 28 V d-c line. This Class B silicon transistor amplifier may be connected for either voltage or current feedback



Questions and Answers about the

GLOBAL COMMUNICATIONS CAPABILITIES of RCA

What capabilities? From which subsidiary of RCA?

From RCA Communications, Inc.

Uncommon capabilities for designing and operating **ground communications networks of world-wide scope** needed by contractors, sub-contractors, and government agencies engaged in **space or missile projects.**

RCA Communications also provides facilities for private communications . . . data communications . . . and commercial communications of all kinds — telegraph, telex, radiophoto, and radiotelephone by means of radio and coaxial cable channels. It designs not only completely new systems but also systems incorporating the most efficient and economical arrangement of established facilities.

How were these capabilities acquired?

Through 41 years experience in building and operating a world-wide communications system. Today, RCA's integrated telegraph, telex, and radiophoto networks reach more than 100 countries and ships at sea.

In what ways does RCA make its capabilities available?

As contractor or consultant. For more information, write RCA Communications, Inc., Advanced Projects Section, 66 Broad St., New York 4. Tel. Hanover 2-1811, Area Code 212.

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for optimum servo response, and is completely protected against normal causes of failure. Full output is achieved with 2V signal into 100K input. Drift is under 10% over rated temperature range of −55°C to 125°C.

Circle No. 226 on Subscriber Service Card

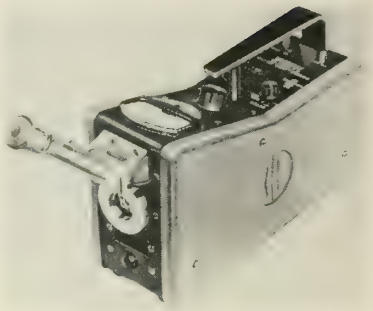
Long-Life Capacitors

A line of capacitors with expected service life of 50,000 hours with 90% confidence has been introduced by Dearborn Electronic Laboratories Inc. Units are rated 100VDC and designed to withstand acceleration, vibration, shock and radiation effects encountered in space-orbital and interplanetary vehicles. All units are subjected to production-line cycling and short-term life tests. Failure rate will not exceed 0.0065% per 1000 hours, and lower rates are being established as proposed in PSMR-1, Department of Defense.

Circle No. 227 on Subscriber Service Card

Sound Wave Meter

A Type 412 sound wave meter is available from H. H. Scott, Inc. The unit, with its accessories, constitutes a



complete measuring and analyzing system for environmental testing and other applications where full information on the characteristics of noise, sound or vibration is required. In addition, the unit can be used as a portable amplifier, voltmeter and attenuator in the audio frequency range.

Circle No. 228 on Subscriber Service Card

Shielded Reed Relay

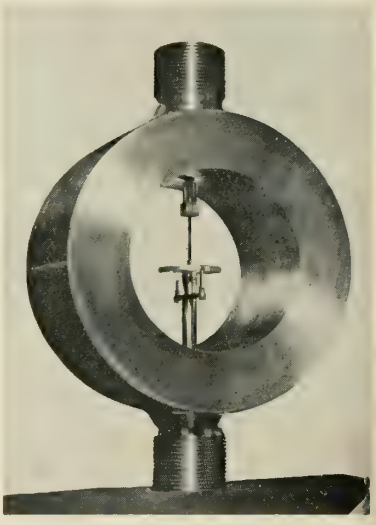
Encased in magnetically shielding enclosures, reed relays with non-magnetic tin-coated #22g copper wire terminals are available from Struthers-Dunn Inc. The units minimize the effects of external magnetic fields, the changing of relay characteristics incurred by cutting or bending heavy magnetic terminals, and the difficulty in soldering them.

The Type RR2A2BS shielded read relays contain two Form A and two Form B break-before-make reed contacts encased in a fully protected steel package. Inherently stable operating characteristics may be utilized fully without need to exercise extreme care in applying the relays.

Circle No. 229 on Subscriber Service Card

Proving Ring

The largest capacity proving ring ever made to the National Bureau of Standards' specifications is available from Morehouse Machine Co. It is capable of measuring compression forces



up to 1,200,000 lb. accurately within 1/10% of applied load. The ring, which is 30½ in. high and weighs 625 lbs., has the standard deflection-measuring apparatus consisting of a micrometer screw and a vibrating reed. NBS calibrated it by using four 300,000 lb. specially made precision proving rings loaded in parallel.

Circle No. 230 on Subscriber Service Card

Counter-Timer

An electronic frequency counter-timer is available from the Ransom Research Division of Wyle Laboratories.

Specifications of the Model 1197 include: 250 kc count rate; 5-digit, in-line projection display readout; 0.25v rms sine or square wave input sensitivity; crystal oscillator time base; 100 kc clock output; external clock input; "Ready" output; "start" and "stop" trigger input; 0.1, 1, and 10-second frequency time gates; 1, 10, and 100 cycle period sample times.

Circle No. 231 on Subscriber Service Card

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POLARIS PROGRAM

All 28 sizes of standardized containers per Navy BUWEPS Drawing List 2210448 as required for Polaris sub-system and other programs are now available for off-the-shelf delivery from both Zero facilities. These rugged, lightweight containers are equipped with latches, pressure equalizers and humidity indicators . . . meet requirements of MIL-T-945A and MIL-21200. Sizes range from 5¼" x 6⅜" to 19" x 22". Easy to accessorize, they are readily adaptable for use as portable instrument cases, transit cases, etc.

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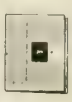

JUST OFF THE PRESS!
Write for catalog with complete specifications and details on these new cases.

Circle No. 12 on Subscriber Service Card

550 to 1100 MC Multicouplers

Applied Research Inc. is marketing a 550 to 1100 mc series of broadband multicouplers, designated HFM-6(A)-55110, available with 2, 3, 4, 6 or 8 outputs. A noise figure of 11 db and a gain of 10 db from input to any output makes this a practical device for field or laboratory use. Nominal 20 db isolation is provided between all outputs.

In addition to regular use for reception over this broadband, the multicoupler has unusual pertinence for system test when used with four or more spectrum analyzers from the same probe.

Circle No. 232 on Subscriber Service Card

Low-Pressure Indicator

Aero Mechanism's Model 8007 is a small, rugged, extremely sensitive low-pressure gauge for wide application in ground support and flight equipment and many critical commercial installations.

Exceptional sensitivity is achieved through a specially designed and built non-corrosive sensing diaphragm. All seals are metallic. Range is 0 to 40 in. of water; accuracy and repeatability is 1 in. of water; operating temperature is −65°F to 185°F and hysteresis is 0.5 in. water; shock and vibration resistance are within MIL-E-5272C.

Circle No. 233 on Subscriber Service Card

new literature

SILICONE POTTING—General Electric has published a brochure on two basic types of silicone materials for potting, embedding and encapsulation of electrical and electronic equipment—the widely used RTV (room temperature vulcanizing) silicone rubber compounds and the new, transparent clear silicone potting compound, LTV-602. The publication, S-23, provides full information on the exceptionally tough RTV silicone rubber compounds and the new, extremely resilient transparent material which provides continual inspection and easy repair of potted assemblies.

Circle No. 200 on Subscriber Service Card

FACILITIES — Computer Equipment Corp. has issued a facilities brochure describing the company's capabilities in the fields of computing and data processing, time and time measurement systems, and hybrid systems which combine the advantages of analog and digital techniques. The brochure explores the fundamentals of hybrid systems as well as the conversion of time intervals into digital form. It also details the company's facilities for research, development and production and gives brief biographies of key management personnel.

Circle No. 201 on Subscriber Service Card

SOFAR—Special Devices, Inc. is currently issuing the first five in a series of Technical Data Memoranda to provide engineers and scientists in the aerospace field with detailed technical information on SDI products and systems. This data includes system or device description, physical and environmental characteristics, applications, advantages and charts and graphs. The technical data immediately available are: SOFAR Bomb (Sound Fixing and Ranging), Infrared Source, EBW (Exploding Bridgewire) Cartridges, EBW (Exploding Bridgewire), Continuity Checker, and Frangible Nut Separation System.

Circle No. 202 on Subscriber Service Card

BANDPASS FILTERS — Applied Research Inc., has published a data sheet for its HFF(A)-6 Series of Bandpass Filters, frequency range 30 to 100 mps. These data sheets for model HFF(A)-6 Bandpass Filters are available from GLM Associates, 1700 K Street, N.W., Washington, D.C.

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Because current Government estimates call for spending between $40 and $70 billion in this decade on space projects. Because some private estimates run as high as—or higher—than $125 billion.

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To put the first man on the moon, or Mars, or Venus . . .

To build B-70's or "Hound Dogs" . . .

To come up with the "Sky Bolt" or the "Minuteman."

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Taken collectively, they constitute a bewildering new world of military products and military expenditures. And they have important implications for the building of houses and highways, hospitals and factories, too.

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Beginning with a thorough-going discussion of the subject in general, the report also provides detailed investment digests on 25 leading companies in the field . . . gives you facts and figures on income, earnings, dividends . . . spells out in detail the place of each in space technology.

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MATHEMATICIANS

SYSTEMS EVALUATION POLARIS SYSTEM

The Applied Physics Laboratory of The Johns Hopkins University has responsibilities in the evaluation of the Polaris Missile System. We invite you to consider the following career appointments:

Senior Mathematicians

Duties will involve statistical analysis of complex test data for performance, reliability and operation evaluations. A background in physics or electrical engineering is desirable.

Project Engineers

For field test operations involving a team effort of Contractor, Navy and APL Personnel. Work will include launch and flight data acquisition analysis and monitoring of shipboard activities related to the Polaris Missile System. Prefer engineers with considerable background of project level responsibilities.

Systems Engineers

APL has several positions available on the associate and senior levels for men with experience in electrical engineering, physics, mechanical engineering, dynamics, or computer engineering. Will perform systems work related to fire control, navigation, missiles, and submarine controls. Assignment involves field work and contact with the Navy and Contractor Personnel.

Systems Analysts

Respondents must have heavy theoretical background and ability to read and understand telemetry records. Will perform basic analysis of systems related to fire control, navigation, missiles, and submarine controls. May also be required to simulate and solve orbit and doppler equations. Associate and senior level appointments.

Data Requirements, Instrument Engineers

Positions require a physicist or electrical engineer with experience in evaluation, data acquisition and testing of instrumentation installations. Will analyze sub-systems such as guidance, propulsion, controls, boosters, and inertial systems individually and as integral parts of over-all systems to derive data requirements and instrumentation. Duties involve some field work.

APL will provide you with a professional atmosphere conducive to creative effort as well as the tools and technical support required to tackle these and related problems. Our facilities are located in Silver Spring, a residential suburb of Washington, D. C., offering you a choice of country, suburban or city living.

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The Johns Hopkins University
8643 Georgia Avenue, Silver Spring, Md.

All qualified applicants will receive consideration for employment without regard to race, creed, color or national origin.

contracts

AIR FORCE

$36,661,947—**The Boeing Co.**, Seattle, for research, development and testing and for depot tooling for assembly and disassembly of the *Minuteman* missile (two contracts).

$8,195,500—**Martin Marietta Co.**, Denver, for *Titan I* missiles.

$7,884,480—**Lockheed Aircraft Corp.**, Sunnyvale, Calif., for design, development and fabrication, and for production of long-lead-time follow items for *Agena B* vehicles and for *Agena* equipment and launch support (three contracts).

$7,261,776 — **General Dynamics Corp.**, San Diego, for product improvement of ground support equipment for the E series *Atlas* ICBM's.

$7,078,396—**Avco Corp.**, Stratford, Conn., for production of ICBM re-entry vehicles and a supplemental contract for research, development and fabrication of a *Minuteman* re-entry vehicle (two contracts).

$7,000,000—**General Electric Co.**, Syracuse, for a weapons control system for defense against air-breathing missiles.

$5,753,055—**Avco Corp.**, Wilmington, Mass., for continued development of nose cones for *Titan I* and *Atlas* ICBM's.

$4,444,764—**General Dynamics Corp.**, San Diego, for providing spares, for site activation, and for work on the test program for *Atlas* ICBM's (three contracts).

$4,435,000—**Sylvania Electric Products, Inc.**, Mountain View, Calif., for engineering, fabrication and installation of prototype radar equipment.

$2,600,857—**North American Aviation**, Canoga Park, Calif., for production of *Atlas* missile propulsion systems.

$2,570,000—**The Boeing Co.**, Seattle, for work on the hardened *Minuteman* system.

$1,786,450—**North American Aviation**, Downey, Calif., for depot tooling of test equipment in support of the *Minuteman* missile.

$1,000,000—**Philco Corp., Western Development Laboratories**, Palo Alto, Calif., for work on *Advent* communications satellite program.

$871,810 — **Page Communications Engineers, Inc.**, Washington, D.C., for transportable tropospheric scatter communications link.

$231,000—**Electro-Optical Systems, Inc.**, Pasadena, Calif., for additional facilities, research and development test equipment.

$130,000—**University of Minnesota**, Minneapolis, for research into behavior of materials and configurations in cyclic-load environments.

$128,982—**Collins Radio Co.**, Cedar Rapids, Iowa, for components of MA-1 flight director systems, data and aerospace ground equipment.

$94,340—**Richie and Associates, Inc.**, Dayton, Ohio, for research in new techniques for control display.

$78,500—**General Electric Co., Missile and Space Vehicle Department**, Philadelphia, for design study of gravity-independent photosynthetic gas exchanger.

ARMY

$28,000,000—**General Telephone & Electronics Corp.**, Waltham, Mass., for continued development of an advanced radar design for the *Nike-Zeus* antimissile system.

$12,376,800—**Western Electric Co.**, New York City, for continued development of the *Zeus* Multi-Function Array Radar (AMAR) for possible incorporation into the *Nike-Zeus* antimissile missile system.

$5,871,420—**Land-Air Inc.**, Chicago, for collection of missile in-flight data at White Sands Missile Range and for research and development of range instrumentation equipment.

$2,623,367—**Hughes Aircraft Corp.**, Fullerton, Calif., for helicopter transportable equipment to coordinate the firing of air-defense missile batteries.

$2,235,805—**Emerson Electric Manufacturing Co.**, St. Louis, for motor metal parts for the *Honest John*.

$2,000,000—**Esso Research and Engineering Co.**, Linden, N.J., for continuation of advanced research into solid rocket propellants.

$2,000,000—**Zenith Radio Corp.**, Chicago, for safety-arming devices for the *LAW* anti-tank rocket.

$1,939,350—**Norris Thermador Co.**, Los Angeles, for production of rockets and rocket motors and bodies, work to be performed at the Vernon Plant.

$1,932,634—**Telecomputing Service, Inc.**, Northridge, Calif., for reduction of missile flight data at White Sands Missile Range.

$1,818,572—**The Hayes Corp.**, Birmingham, Ala., for work on training equipment to be used in connection with the *Pershing* missile system.

$1,400,000—**Raytheon Co., Missile and Space Division**, Bedford, Mass., for *ARPAT* project.

$1,143,835—**Hughes Aircraft Co.**, Fullerton, Calif., for equipment to test printed circuit cards in the missile monitor system.

$1,020,210—**Chrysler Corp.**, Detroit, for support services and depot maintenance of the *Redstone* missile.

$370,237—**The Emerson Electric Manufacturing Co.**, St. Louis, for product and production engineering and quality assurance services supporting *XM50* improved *Honest John*, less warhead.

MISCELLANEOUS

$350,000—**High Vacuum Equipment Corp.**, a subsidiary of **Robinson Technical Products, Inc.**, Hingham, Mass. from **General Electric's Missile and Space Vehicle Department**, for a space simulation thermal test facility.

$714,000—**Cessna Aircraft Co.**, Wichita, from the **Boeing Co.**, for transport-erector containers for the *Minuteman* missile.

$600,000—**Temco Electronics**, Arlington, Tex., from **The Boeing Co.** for design, development, test and manufacture of flight-control-surface hydraulic valve assemblies for the *Dyna-Soar*.

$250,000—**McCormick Selph Associates, Inc.**, Hollister, Calif., from **Martin Marietta** for development of the exploding bridgewire ordnance system to be used on the *Pershing* missile.

$200,000—**The Leach Corp.**, Azusa, Calif., from **The Boeing Co.** for sub-miniaturized telemetry receivers for the *Minuteman* program.

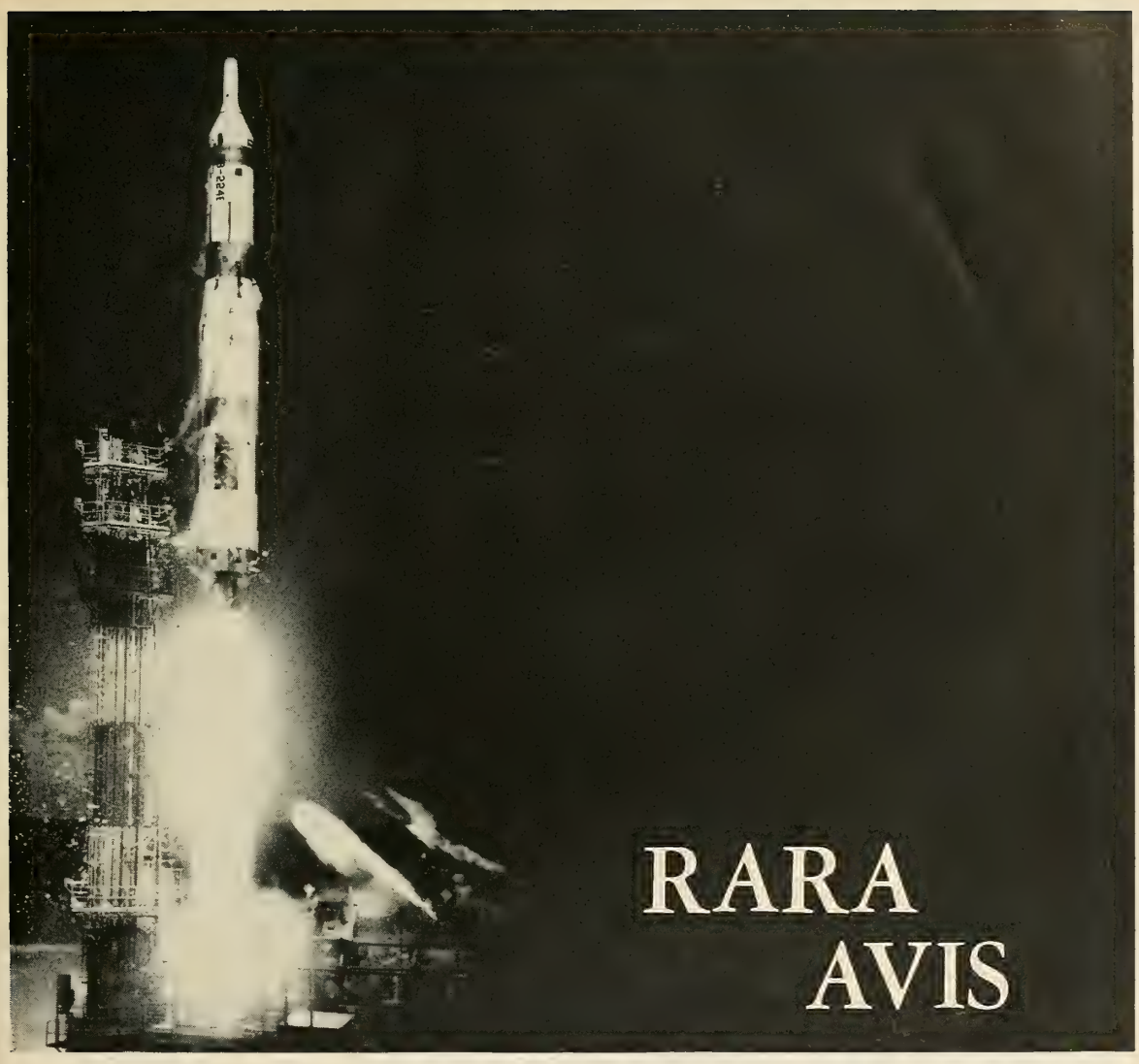
NASA

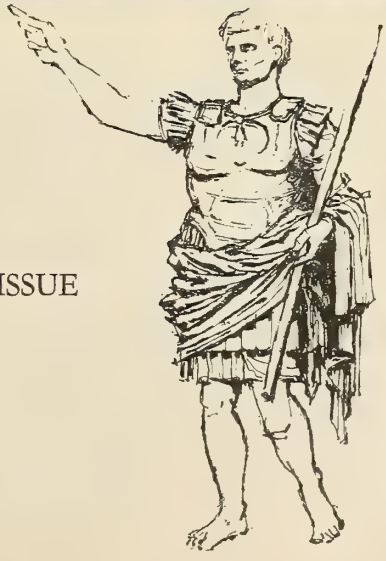
$74,568—**Cornell Aeronautical Laboratory, Inc.**, Buffalo, for services in study of processes occurring when satellites are impacted by meteoroids, work to be accomplished for Lewis Center, Cleveland.

NAVY

$9,609,900—**Hercules Powder Co.**, Wilmington, Del., for continued research and development on solid propellant for *Polaris* missiles.

$1,199,921—**Electrics, Inc.**, Lompoc, Calif. for installation of range safety test communications cable plant, Naval Missile Facility, Point Arguello and Vandenberg AFB, Calif.





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publishing date: March 26, 1962
advertising closing date: March 5

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Experience in research, development and testing of rocket components, gas generators and associated equipment.

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Frank W. Godsey, Jr.: Former vice president of Westinghouse and a past president of Electronic Communications, Inc., elected director and chairman of the board of Dev-Tek, Inc., Orlando, Fla. Currently a director of Globe Capital Corp., St. Petersburg, Godsey was president of E.C.I. until his resignation last June. He was also a vice president in charge of all military and commercial electronics at Westinghouse Electric Corp.

Capt. C. E. Pruett, USN: Bio-Science Staff Officer, Pacific Missile Range, elected president for 1962 of the Pacific Missile Range Section of the American Rocket Society. The rest of the newly elected slate of officers: **Harry Burkholder,** vice president; **Arthur Menken,** secretary-treasurer; **W. A. Eberspacher,** membership chairman; **Col. J. G. Redmon, S. R. Radom, L. E. Wood, LCdr J. E. Draim** and **John E. Masterson,** directors.

Russell C. Coile: Named director of research for a newly organized section of the Operations Evaluation Group, Massachusetts Institute of Technology. In his present position he will direct research for a new Marine Corps Section, conducting operations analysis in such areas as amphibious warfare, strategic planning, air warfare, submarine and anti-submarine warfare, and logistics.

George D. Gotschall: Vice president of Steel Improvement and Forge Company, made general manager of all domestic forging operations. He is returning to the U.S. from a three-year leave of absence in South America where, under a technical assistance contract between Steel Improvement and Industries Kaiser Argentina (IKA), he has served as general manager of the forging division of IKA at Cordoba, Argentina. Gotschall selected and led the team of technical specialists which planned and organized the IKA forging division, including construction of the facilities and training of the labor force.

Robert A. Wolf: Promoted to head of Vehicle Dynamics Department of the Cornell Aeronautical Laboratory. **Robert M. Stevens** succeeds Wolf as head of the Operations Research Department; and **Arthur Stein** becomes assistant head of the Operations Research Department. Wolf, a member of the laboratory's technical staff since 1951, will continue as director of the Automotive Crash Injury Research project of Cornell in New York City. Stevens has been with the laboratory since 1949, and Stein since 1955.

Anthony A. DeLisse and **Glenn E. Ronk:** In recognition of expanding activity in the field of electromechanical products under DeLisse, and the importance of Ronk's responsibility as director of the recently integrated marketing organization, both have been named vice presidents of Cornell-Dubilier Electronics, Newark, N. J. DeLisse is manager of the company plant in Fuquay Springs, N. C., responsible for all phases of engineering and production. Ronk supervises product planning, pricing, order service, application engineering and associated marketing functions, and directs activities of the marketing managers at the six C-D plants.

Dr. Frank J. Rosato: With Sylvania Electric Products Inc. since 1953, to head up a new aerospace research department within the Applied Research Laboratory of Sylvania Electronic Systems. He will be responsible for conducting long-range studies of new concepts and systems techniques applicable to space technology. Rosato has managed the engineering research department and directed work on space-deployed weapons systems and command and control aspects at the Applied Research Laboratory for the past two years.

Joseph Kalla: Designated director of space-defense programing by the American Optical Company, will be responsible for coordination of all the company's space and defense efforts. In addition to his new duties, Kalla will continue to supervise sales of American Optical's Fecker division. He has been associated with the company since 1956.

William G. Miller: Elected president of Alco Products, Inc., to succeed **William S. Morris,** who retired. Miller joined Alco in 1932 as a project engineer and has held various responsible positions prior to the present one.

Dr. John Doherty: Named senior staff physicist in the Research Section of Bendix Computer Division's Engineering Department. Prior to his present appointment, Doherty was associated with the National Cash Register Co. and with Servomechanism, Inc., specializing in thin-film research in both positions.

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when and where

JANUARY

30th Annual Meeting, Institute of the Aerospace Sciences, Hotel Astor, New York City, Jan. 22-24.

National Plant Engineering and Maintenance Show and Conference, Convention Hall, Philadelphia, Jan. 22-25.

Solid Propellant Rocket Conference, ARS, Baylor University, Waco, Tex., Jan. 24-26.

American Society of Mechanical Engineers, 2nd Symposium on Thermo-Physical Properties, Princeton, N.J., Jan. 24-26.

FEBRUARY

Western Electronic Week and Pacific Electronic Trade Show, Palm Springs, and Los Angeles, Feb. 3-11.

Winter Convention on Military Electronics, IRE, Ambassador Hotel, Los Angeles, Feb. 7-9.

International Solid State Circuits Conference, Philadelphia, Feb. 14-16.

Tracking and Command of Aerospace Vehicles, Institute of the Aerospace Sciences, San Francisco, Feb. 19-21.

Third Annual Symposium on Nondestructive Testing of Aircraft and Missile Components (Southwest Research Institute), Gunter Hotel, San Antonio, Tex., Feb. 27-Mar. 1.

MARCH

Institute of Radio Engineers, 8th Scintillation and Semiconductor Counter Symposium, Washington, D.C., Mar. 1-3.

Fifth Annual Technical Conference, Society of Vacuum Coaters, Sheraton-Cleveland Hotel, Cleveland, Mar. 6-7.

Armed Forces Communications and Electronics Association, Cape Canaveral Chapter, symposium, Cocoa Beach, Fla., Mar. 6-8.

Flight Propulsion Meeting (classified), Institute of the Aerospace Sciences, Cleveland, Mar. 8-9.

1962 Symposium on Packaging of Chemical Products, sponsored by Manufacturing Chemists' Association, Inc., St. Louis, Mar. 13-14.

Goddard National Space Conference, sponsored by the National Rocket Club, Sheraton Park Hotel, Washington, D.C., Mar. 14-16. (Goddard Memorial Dinner on Mar. 16.)

Third Symposium on Engineering Aspects of Magnetohydrodynamics, sponsored by University of Rochester, AIEE, IRE, IAS, University of Rochester, N.Y., Mar. 28-29.

APRIL

American Rocket Society, Launch Vehicles: Structures and Materials Conference, Ramada Inn, Phoenix, Ariz., April 3-5.

Thirteenth Annual Advanced Statistical Quality Control Institute, University of Connecticut, Storrs, April 8-20.

Institute of Environmental Sciences, Annual Technical Meeting and Equipment Exposition, Sheraton Towers Hotel, Chicago, April 11-13.

Second Conference on Kinetics, Equilibria, and Performance of High-Temperature Systems, Western States Section, The Combustion Institute, University of California, Los Angeles, April 14-16.

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Solid Support Is Needed

EARLY LAST YEAR, an editorial on this page began:

"Tentative steps now are being taken toward a large solid-rocket booster program which could serve as a backup to the *Saturn* liquid program. It is an effort which should receive all the financial support necessary to move it forward at optimum speed."

In May, President Kennedy told a joint session of Congress:

"We propose to develop alternate liquid- and solid-fuel boosters much larger than any now being developed until certain which is superior."

Necessary support for a big solid program seemed assured.

It never materialized. Aerojet-General and United Technology successfully demonstrated during the year the feasibility of large segmented solids, but even these firings failed to generate any apparent enthusiasm for an accelerated program.

In his characteristically blunt fashion, Dr. Harold W. Ritchey, Thiokol vice president, labels the situation a "national tragedy" (see p. 13).

In Dr. Ritchey's view, the failure to implement a big solids program is resulting in forfeiture of one of our best chances of beating the Russians to a manned lunar landing. He says there is a lack of confidence in solids.

This might seem to place the blame directly on the National Aeronautics and Space Administration. The situation is not necessarily that black and white. Administration sources point out that NASA does have two alternate programs for the manned lunar landing—direct flight and rendezvous. The solid booster program therefore has been downgraded to "backup" status and eliminated as a contender for the initial manned lunar landings. Studies are continuing, but there is no extensive funding for a third major program.

Talk of further feasibility studies does not appease Dr. Ritchey. Feasibility of a big solid engine—and he is talking of a first stage with upwards of 20 million-pounds thrust—is well established, in his expert opinion. Further studies will result only in further delay.

Without question, Dr. Ritchey speaks from a position of self-interest. If a big solid program is funded, Thiokol would very much like to take part—and the company has a quite interesting proposal. The Thiokol executive also appears somewhat more concerned than do backers of the segmented solids.

But Dr. Ritchey's views deserve serious consideration. He is a man of acknowledged technical competence, a senior official of a responsible firm, and a past president of the American Rocket Society.

He also is consistent. Dr. Ritchey speaks of a program which could lead to initial test of a 240-in. flightweight solid motor in 18 months.

Last March, he was quoted in this magazine as saying of such a motor:

"If we were in a hurry, we could have it in 18 months."

In Dr. Ritchey's view, every month between then and now has been a month wasted. Although progress has been made in segmented solids at Aerojet and UTC, as well as at Lockheed Propulsion Co., those feasibility programs will run into a dead end unless financial support for a big solid booster is forthcoming.

WE DO NOT CARE whether such a booster is segmented, laminated, sliced or gold-plated. But the ineritia which has slowed solid development must be overcome. The nation can ill afford to let the solid program lag by default and that is what appears to be happening.

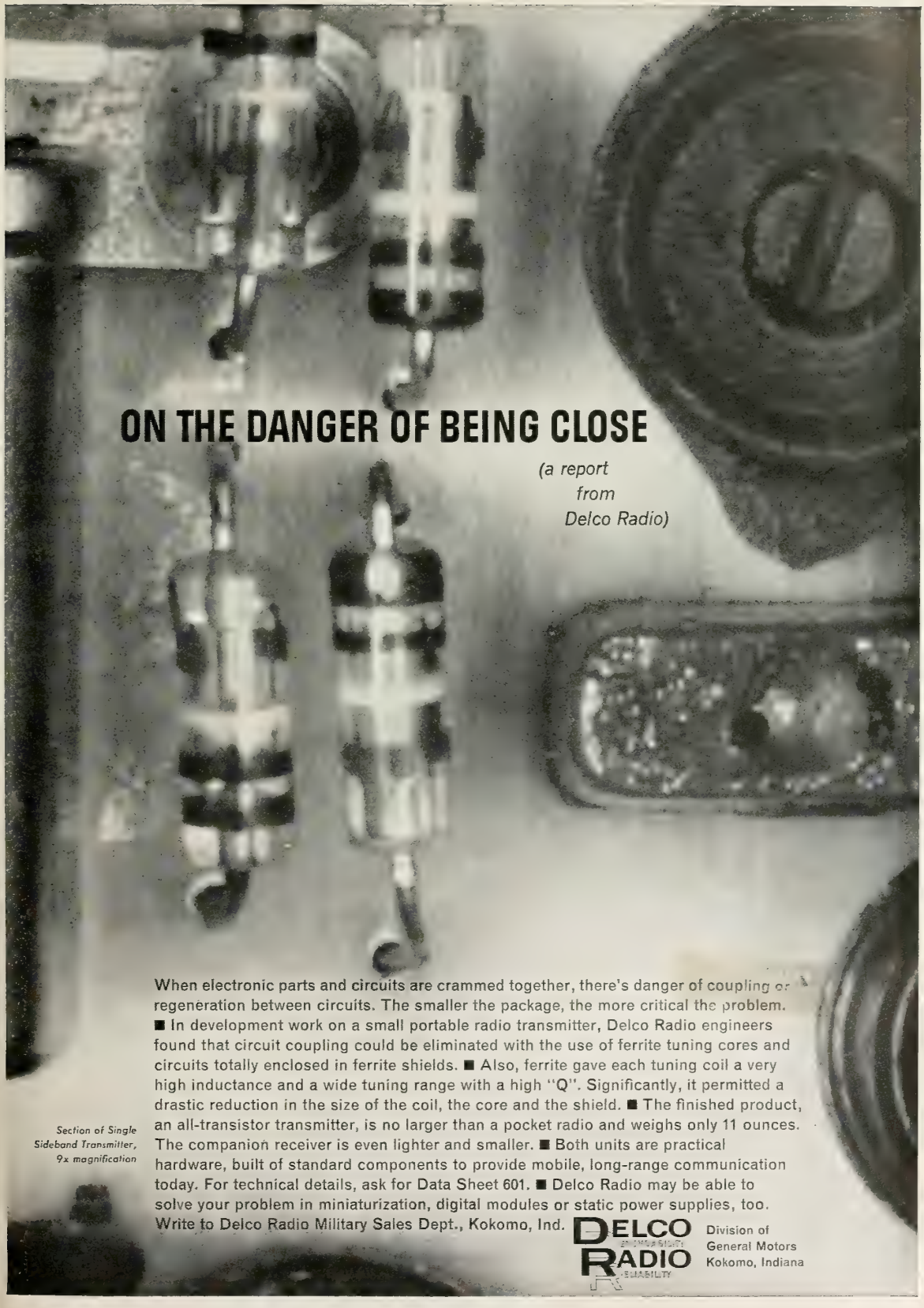
The Air Force, charged with development of big solid boosters, has not been in a position to undertake a major program without a NASA requirement. The Air Force, at the moment, has no acknowledged mission of its own which would require such a booster. That situation may be changed and such a change could greatly benefit the solids program.

Meanwhile, the lack of support is resulting in stagnation in the solids.

No one, and certainly not Dr. Ritchey, has suggested that development of the big liquid booster be stopped or slowed down. It is imperative that that program be kept rolling. But it is equally imperative that major support be provided for solid booster development. All indications point to the fact that we are ahead of the Soviet Union in this field. We must stay there. To wait until the Russians have unveiled a big solid booster is the path of folly.

We compliment Dr. Ritchey on his frank opinions. We hope someone takes them as seriously as he stated them.

William J. Coughlin



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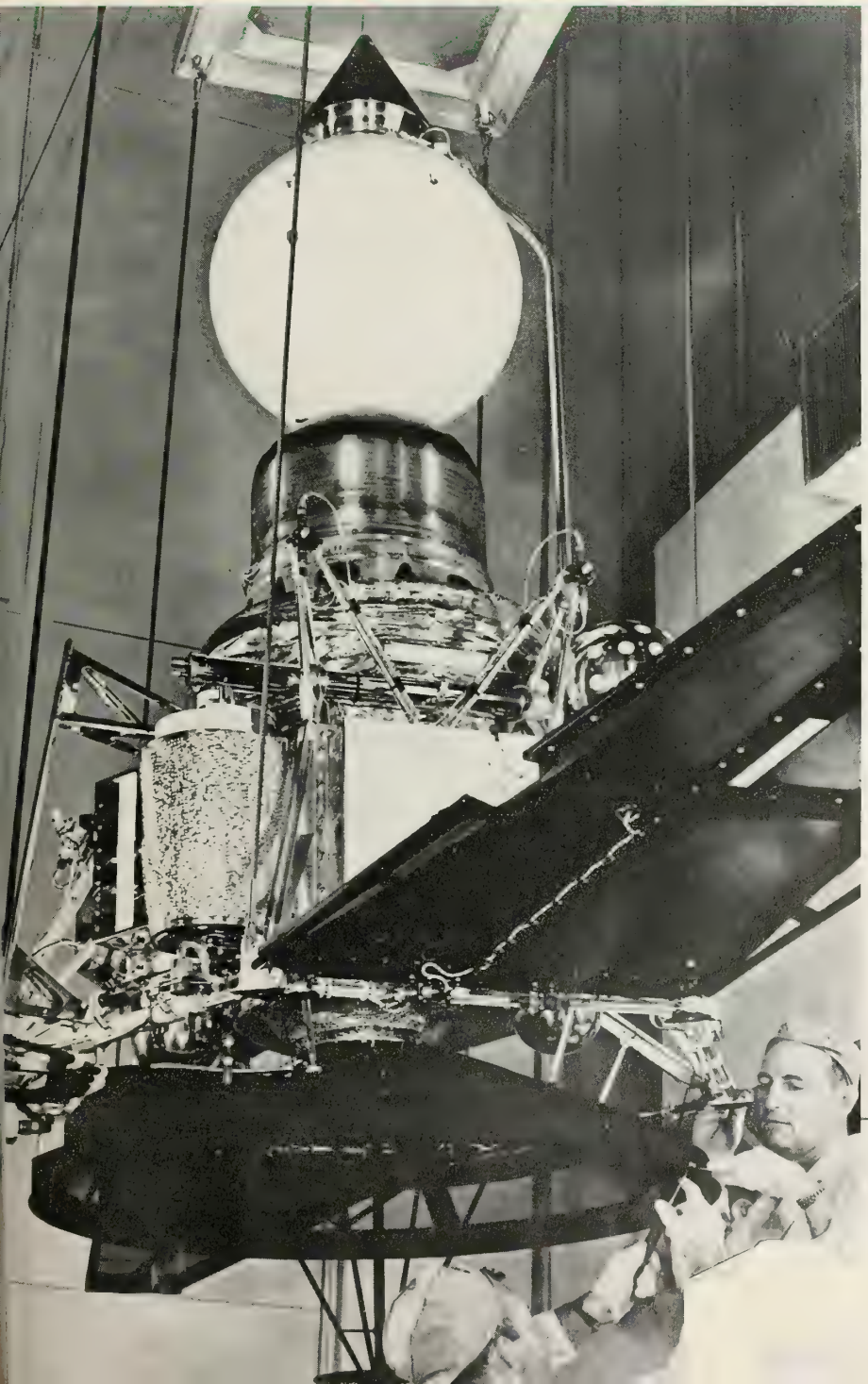

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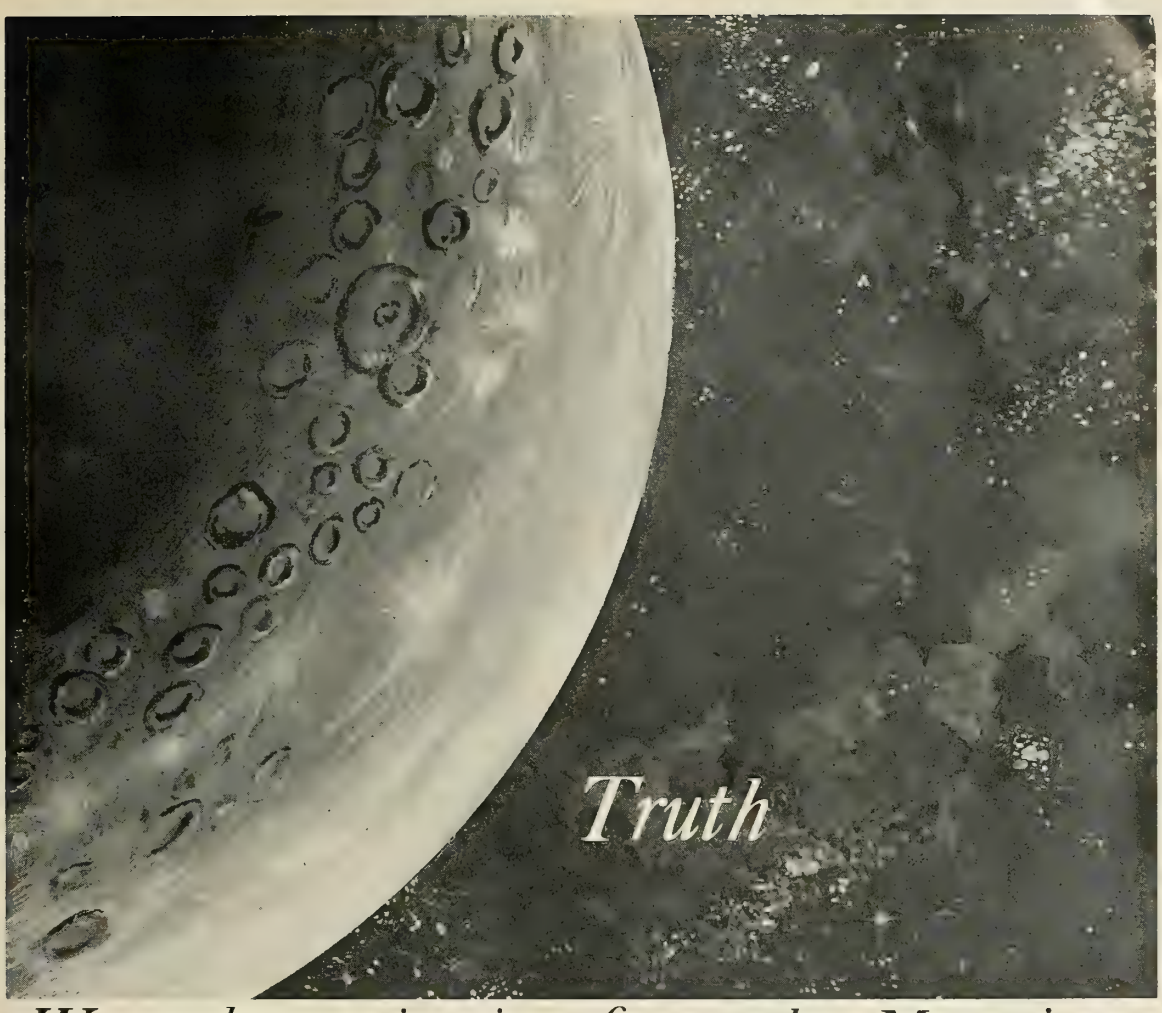

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missiles and rockets

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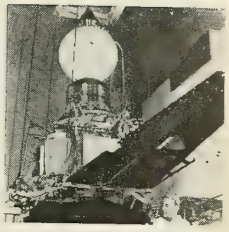
THE COVER

JPL technicians adjust antenna on NASA's Ranger III lunar-landing spacecraft, due to be launched this week. Balsa-wrapped impact capsule is at top. The launch is most complicated unmanned shot yet. *See p. 18.*



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letters

Patent Amplification

To the Editor:

Let me take this opportunity to compliment you on the very fine editorial called "The Two Sides of the Patent Coin" (M/R, Dec. 11). To my mind, the presentation was a deft one which succeeded in highlighting some of the very difficult aspects of this whole question of patent ownership.

I would like to emphasize two things in connection with your editorial.

One is that I think you could have made even stronger the suggestion that today we are being forced to "settle for less than the best" in securing research and development work for the Federal Government. Of course the work is going to get done, one way or the other. Of course it is easy to find people who will accept the contracts. But the real question is whether we are getting the most talented people and the best ideas that are available within the very organizations doing the research, or whether the best, most competent and economical researchers were absent from the original bidding.

I submit that even those who do the contracting are in no position to know whether they are getting the best research under such restrictive patent clauses as those contained in NASA contracts—simply because they don't know what is not being offered or what is being withheld. Thus it makes little sense to say that the fact that we can always find somebody to accept Government contracts is proof of the concomitant fact that the research is good.

The second point that I would emphasize is that testimony before our Subcommittee recently has indicated quite strongly that industry is generally aware of the need to make sure that subcontractors and individual inventors are adequately rewarded for the work they do. On the basis of this testimony, it would seem to me now that there is a growing tendency for employee participation in the results of patents they produce through full or partial ownership or sharing of profits which may accrue as a supplement to the individual incentive awards which are in most instances already in existence.

At the same time, it is indicated that the small researcher or manufacturer who is usually in a subcontract position has a great stake in maintaining ownership of patents. In his dealings with the Government or with the prime contractor, he fights to hold control of his patents because this affects the integrity of his company and his ability for further growth. A good patent is an asset on which he can build and through which money can be borrowed or investors attracted.

MISSILES AND ROCKETS is to be commended for keeping this important patent issue before the public.

Emilio Q. Daddario, M.C.
Committee on Science and Astronautics
House of Representatives
Washington

Shortening

To the Editor:

I am surprised to see in the Jan. 1 M/R (Letters, p. 4) that you did not refer Mr. John A. Main to the *Guide to the Space Age* (Prentice-Hall, Inc., 1959), which lists M/R as a source.

Mr. Main will find the dictionary of aerospace abbreviations and acronyms which he seeks contained in this book.

Thomas R. Armstrong
Hackensack, N.J.

To the Editor:

I note with approval John A. Main's endorsement of reader August Graf's suggestion. Mr. Main's letter gives a few examples . . .

The situation could be confounded if more than one such letter grouping has a multiple meaning, such as MAD (either Magnetic Airborne Detector or Motor Assembly and Disassembly), but this is of minor import yet (I hope!).

An attempt was made in this direction. A glossary (Section 10) of C. W. Besserer's *Missile Engineering Handbook* (D. van Nostrand Co., 1958) incorporates some of these terms.

This was but a shadow of the substance, of course. In addition to acronyms, there are, of course, certain abbreviations (GSE, MHD, etc.) which it would be nice to have a source of reference for. Even an "old hand" might be puzzled by one of the more obscure ones occasionally.

Especially, a slightly detailed derivation of the term might prove a help to scholars. This might even explain a few things.

Such as how one can get *EGO* out of *Eccentric Orbiting Observatory* (M/R, Jan. 1, p. 9).

Stephen A. Kallis, Jr.
Dunedin, Fla.

P.S. Amen to your Jan. 1 editorial ("The Spartan Approach to Space"). Especially the closing sentence!

Well, Yes and No

To the Editor:

In COUNTDOWN, M/R Jan. 8, p. 9, you used the word "antennae." Not only is this word incorrect for "antennas" in the radio sense, but the sentence structure calls for the singular word "antenna."

Carlyle R. Smith, Lt. Col., USAF
Chief, Comm & Elct Div
Directorate of Operations
DCS/Procurement & Materiel
Air Force Systems Command
Andrews AFB, Washington

M/R violated its own style by using "antennae"; however, the new unabridged Webster's lists it as an acceptable spelling ("antennas" preferred) in the radio sense, and the Van Nostrand Scientific Encyclopedia uses the two spellings interchangeably. The item referred to mentions "completion of the first two ground antennae receiving stations"—we fail to see that this is really less correct than "ground antenna receiving stations."—Ed.

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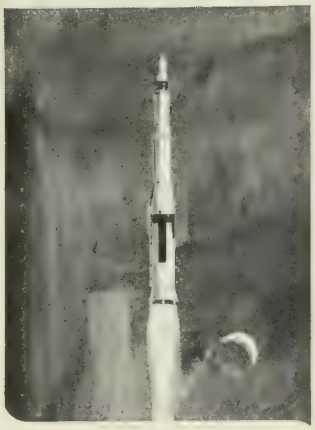

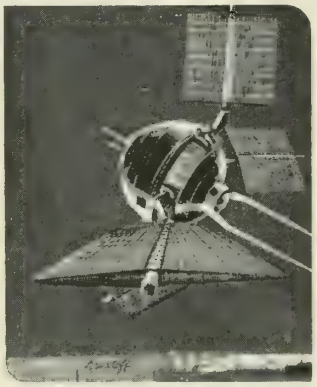

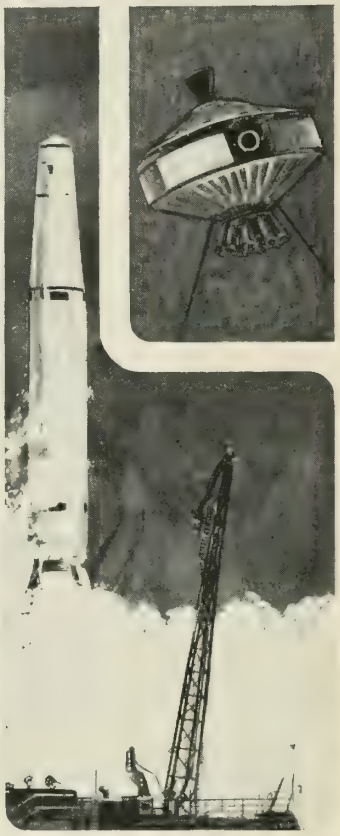

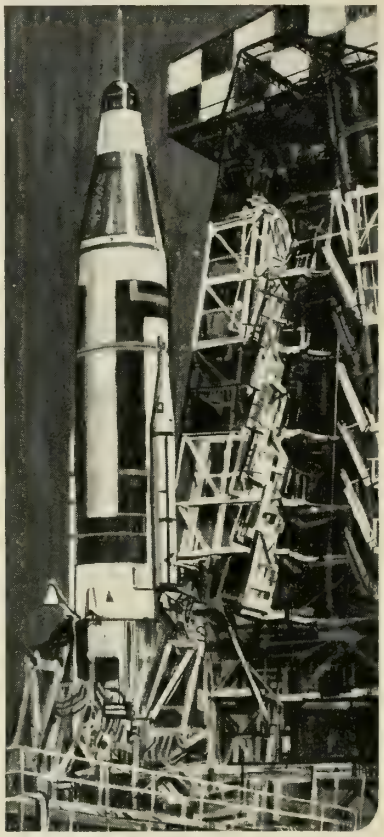

Of particular interest to engineers and scientists is the continuing growth and diversification of Space Technology Laboratories, Inc. What is now STL was founded as the Guided Missile Research Division of the Ramo-Wooldridge Corporation in 1954, when the Ballistic Missile Program was given highest national priority. ■ Assigned contractual responsibility for the program's systems engineering and technical direction, STL has grown in parallel with the need for its capabilities—from a small group of engineers, scientists and administrators to an industrial organization with a professional staff numbering more than 2,000 with 2,500 supporting personnel—from its initial headquarters in a suburban Los Angeles schoolhouse to the ultra-modern STL Space Technology Center nearing completion on a 110-acre site at One Space Park, Redondo Beach, California, close to Los Angeles International Airport. ■ During its years of Space Technology Leadership, STL has contributed importantly to the management of a program that, in a successful race against time, has given this nation the Thor, Atlas, Titan and Minuteman ballistic missile systems. At the same time, STL has been called upon to design, fabricate, instrument and successfully launch Pioneer I, Explorer VI and Pioneer V—all of which were tracked and commanded by STL's world-wide space communication network (SPAN)—and to contribute to the management of the Transit 1B, Transit 2A, Transit 3B, Courier 1B and Tiros programs. ■ Today, STL in addition to its continuing role in the USAF Atlas, Titan and Minuteman programs, is performing research, development, design and construction for three Orbiting Geophysical Observatories (OGO), as well as project coordination and systems planning for Project Relay, both for NASA; and participating in the Army Advent communication satellite project. STL's continuing program of original and applied research covers a broad spectrum of technical disciplines including particle physics, solid state theory, guidance space physics, communication theory, propulsion and power, and electromagnetic systems in the infrared, ultraviolet and microwave regions. ■ The expanding activities of STL create immediate career opportunities in Southern California and at Cape Canaveral for engineers and scientists of talent and vision. All qualified applicants are invited to communicate with Dr. R. C. Potter, Manager of Professional Placement and Development. STL is an equal opportunity employer.

Career opportunities exist at STL for qualified engineers and scientists in support of these programs:

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405A

The Countdown

WASHINGTON

Dyna-Soar on the Range

Air Force plans for orbiting manned *Dyna-Soars* now call for establishing a seaborne tracking range around much of the globe. The *Mercury* net or another land-based system will not be used, for political reasons. The first *Dyna-Soar* launchings now may take place as early as 1964.

Orbital Pricetag—$400 Million

Total cost of the *Mercury* through the upcoming first manned orbital flight is pegged at about $400 million. The breakout: about $160 million to the prime contractor, McDonnell; $95 million for the tracking network; $85 million for boosters, including *Atlases, Redstones* and *Little Joes;* $25 million for recovery operations; $35 million for supporting research.

'Unity' at the Pentagon

Congressmen are expected to take pointed jabs at the Defense Department for what some are already calling the "unification budget." One prime target: the failure of the new budget to include total appropriation requests for the military services by service.

Whither Zeus?

Top Pentagon officials are still saying some cutting things about the *Nike-Zeus* system in defense of the decision to chop production funds from the new budget. However, the Army is still betting that successful tests in the Pacific this year will lead to production money in FY '63.

NASA—Jobs Aplenty

NASA's doubled ($3.7-billion) FY '63 budget will mean the hiring of 5000 more employes—half of them scientists and engineers. This would bring the space agency's requirement for new professional men to 4500 over the next two years. If the budget goes through Congress intact, NASA will have a payroll of more than 26,000 by mid-1963.

INDUSTRY

Nerva Contract On Way

Award of a new contract giving Aerojet-General and Westinghouse permanent responsibility for developing the *Nerva* nuclear rocket engine is imminent. The two firms, which currently hold a six-month contract, will receive a new one for six months—but with a provision for a five-year extension.

Saturn Advances

Signing of a *Saturn C-1* production contract with Chrysler calls for only an initial $10-million payment, but the contract is expected to run well over $200 million . . . NASA also has awarded a $505,000 contract to Consteel and Ets-Hokin & Galvan for building the 240-ft umbilical tower on Cape Complex 34, where *Saturns* will be launched. The tower is due for completion this year.

R&D Intelligence

Pad 19 at the Cape will be used for *Titan II* launches of NASA's two-man *Gemini* . . . Only 10 *Atlas F's* remain on the R&D flight schedule . . . The Air Force and Northeastern University will launch an *Astrobee 200* Jan. 25 to an altitude of 180 mi. from Eglin AFB, in an experiment measuring light emissions . . . Fairchild Camera is readying a $2-million facility at Syosset, L.I., N.Y., for testing high-performance optical systems in a space environment . . . Weathermen are eyeing the possibility of marrying communications satellites to weather satellites for faster data distribution.

Computers on the Move

RCA expects this year to gross $200 million from all of its data-processing activities . . . IBM is introducing its 7094 data-processing system—an improvement on the 7090—with a 2-microsecond memory-reference speed . . . North American's John R. Moore, president of Autonetics, predicts that by 1970 it will be possible to build devices with 10 million interconnecting parts—all packed in one cubic foot.

Front Office

Gen. James H. "Jimmy" Doolittle is stepping out as chairman of the board of STL upon reaching the company's retirement age of 65. He's succeeded by President Dr. Louis G. Dunn . . . The two prime professional societies in the space field—American Rocket Society and Institute of Aerospace Sciences—are studying the possibility of merging. One objective: "eliminating unwarranted duplication of functions"—presumably extending to technical meetings.

INTERNATIONAL

Overseas Pipeline

The Observatory of Paris's new radiotelescope at Nançay in central France is operational. More powerful than Jodrell Bank, the big 'scope already has reported the temperature on the moon at a 1-meter depth to be −30°C . . . Britain's Handley Page is proposing a new Super Victor bomber to carry six *Skybolt* ALBM's . . . The deal has gone through for Switzerland to buy 700 British Aircraft Corp. *Bloodhound* Mark 2 antiaircraft guided missiles. The $70-million contract is the largest foreign order ever placed for a British guided weapon.

Red Oneupmanship?

On the eve of the U.S. manned orbital flight there's speculation Russia may try to grab the limelight by sending two men into orbit in a *Vostok*. Presumably the Red flight would last several days, permitting them to monitor the three-orbit U.S. flight from on high.

The Missile/Space Week

Army Revamping Tech Services In Pattern Similar to AFSC

The Army is preparing to remodel its technical services along the lines of the new Air Force Systems Command.

The plan—still subject to congressional approval—would create a new Army Materiel Development and Logistics Command. MDLC would become responsible for R&D, procurement and production, inventory management, storage and distribution, and maintenance.

Eliminated in the wholesale reorganization will be the offices of the chief of ordnance, chief chemical officer, quartermaster general, chief of finance, chief signal officer, chief of transportation, and adjutant general.

The various technical services will be retained as branches, however, and there will be no significant changes in arsenals, laboratories, depots, test ranges or installations. But control and direction of these facilities will be shifted from these technical services to the new MDLC.

Army officials said the new setup will mean that industry contractors will deal with one agency—MDLC—eliminating "duplication of effort and excessive fragmenting of functions, responsibilities and resources."

Unless there is a hitch in Congress the plan will go into effect in 30 days. Some 18 months will be needed to complete the reorganization.

Pershing Progresses

PERSHING shown in Jan. 16 firing at Cape Canaveral. Army reported the Martin IRBM went 100 mi. beyond 300-mi. range of Redstone, and that this version, shorter than earlier models, approaches operational version of the missile.

Hayward Goes to Sea; Raborn Gets His Berth

Vice Adm. John T. Hayward, deputy chief of Naval operations (development), will move from his present job to a carrier command within the next two weeks.

Replacing Hayward will be Vice Adm. William F. Raborn, head of the Navy's Special Projects Office, who also will work closely with James H. Wakelin, Assistant Secretary of the Navy (R&D). Rear Adm. Ignatius J. Gallantin, in turn, will take over Raborn's *Polaris* post.

Hayward's voluntary decision to go to sea means a one-step reduction in rank. However, he was undoubtedly influenced by Navy precedent, which has customarily selected chiefs of Naval operations from officers with sea-going assignments.

Red 'Asteroid Bomb' Threat

Russia may have enough rocket power by 1970 to knock out North America with an "asteroid bomb."

GE's Dandridge M. Cole told the American Astronautical Meeting in Washington that asteroids moving between Mars and the earth could possibly be diverted to hit the earth with power equal to millions of H-bombs.

He said a *Nova*-type vehicle could, hypothetically, push an asteroid with a diameter of three miles and weight of 500 billion tons out of its normal orbit and make it hit a pre-selected target on earth.

Cole told the AAS annual meeting that there were probably thousands of these close-approach asteroids awaiting discovery.

Shots of the Week

An *X-15* research plane rocketed to 3715 miles per hour in a test of a new control system.

NASA test pilot Neil Armstrong was at the controls of the plane. He reported that the *X-15* worked "pretty good" during the flight.

The control system is designed to aid the pilot by sensing motions and automatically feeding corrections into the controls.

In other shots:

- NASA's rigidized *Echo* inflatable communications satellite was torn to shreds shortly after injection from its *Thor* booster.
- The Army's *Pershing* missile was launched successfully on its longest test. Officials said that all test objectives were met during the 400-mile flight.
- The Air Force also launched successfully an *Atlas D* intercontinental ballistic missile from its horizontal, so-called "coffin" launcher. The Air Force declined to give the distance of the shot.
- NASA launched successfully a two-stage *Aerobee* sounding rocket to an altitude of 130 miles to gather information for planning future astronomical satellites. The launch—on Jan. 13—was from Wallops Is.
- Another launch in the Air Force's *Discoverer* series failed when the capsule did not go into orbit. The attempt was made on Jan. 13.

The *Echo* satellite suborbital test was launched by NASA on Jan. 15. The mammoth satellite burst apart about 25 minutes after launching and shortly after it left its *Thor* booster.

Dramatic pictures of the breakup were taken by two cameras in the booster, but officials still have not nailed down the precise reason.

Two possible causes were that the satellite inflated too rapidly or that it may have been torn while it was folded into its canister.

Booster Debate Warms

A top missile/space industry executive has charged that the Kennedy Administration has failed to rectify the cleavage between the U.S. military and civilian space programs.

ASW Research Hydrofoil Makes Public Debut

HYDROFOIL and catamaran hull are features of Lockheed-California Co. research craft skimming above water during tests at Naval Ordnance Test Station, Calif. ASW study vessel, powered by 1000-lb.-thrust Fairchild J-44 jet engine, is designed to reach speeds topping 86 mph. Experiments are being funded by Navy contracts.

Dr. Arthur Kantrowitz, vice president of Avco Corp., chairman of an American Rocket Society panel discussion in New York City, also hit at the development of civilian space boosters.

He favored utilization of existing production-line military boost vehicles coupled with development of orbital rendezvous techniques over creation of large and expensive non-military launch vehicles.

Dr. Ernest Roberts, vice president of Aerojet-General Corp., however, agreed with the multiple approach of space exploration by NASA and the armed services.

NASA's Manhattan Lode

NASA's drive to hire 2000 scientists and engineers by June 30 is getting a big push during its current recruiting drive in New York City.

More than 900 inquiries and 550 personnel interviews were handled by space agency recruiting teams during their first three days in the city.

The heavy response forced the NASA officials to add three more days to their planned stopover. The second round of interviews will be held Jan. 23-26.

Though obviously pleased and encouraged by the response in New York, NASA officials point out that success of the nation-wide recruitment program will only be known when actual hiring figures are announced.

The drive began in Chicago on Nov. 1. About 4000 persons have been interviewed to date with about 1000 described as "NASA types."

JFK Moves Against Shortage

President Kennedy has ordered his scientific advisers to draw up a report "as quickly as possible" on how the U.S. can cure its worsening shortage of scientists and engineers (M/R, Jan. 1, p. 12).

At his news conference last week, the President called the dwindling supply of graduate scientists and engineers, described in a recent report of the National Science Foundation, one of the "most critical problems facing this nation."

He said he had asked his Science Advisory Committee, assisted by the Federal Council for Science and Technology to "report to me as quickly as possible on specific measures" the government and industry can take to meet the crisis.

He said he had also asked the National Academy of Sciences to make a new study of the problem.

Helium Belt Spotted

Scientists have discovered that a band of helium exists around the earth at altitudes between 600 and 1600 miles.

NASA physicist Dr. Wolfgang Priester revealed the band's existence in a paper presented to the Air Force Lectures in Aerospace Medicine in San Antonio (see p. 28). He said the helium was detected by the *Echo I* and *Explorer VII* satellites.

QUALITAS
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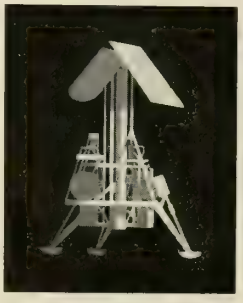
systems analysts
To consider such basic problems as the requirements of manned space flight; automatic target recognition requirements for unmanned satellites or high speed strike reconnaissance systems; IR systems requirements for ballistic missile defense.

infrared specialists
To perform systems analysis and preliminary design in infrared activities involving satellite detection and identification, air-to-air missiles, AICBM, infrared range measurement, air-to-air detection search sets, optical systems, detection cryogenics and others.



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Record $16.2 Billion Sought

Kennedy's missile/space request tops Ike's last by $6 billion; $20 billion seen for FY '64

by James Baar

THE KENNEDY Administration is asking Congress to pour a record-shattering $16.2 billion into the nation's booming missile/space programs for FY '63.

The huge missile/space appropriation request—more than 16% of the $99.3 billion Federal budget that President Kennedy sent to Capitol Hill last Thursday—is some $6 billion higher than the amount the Eisenhower Administration sought just one year ago.

Nor is the end in sight.

Top government officials forecast that missile/space money requests will rise at least another $3-billion-to-$4-billion in FY '64.

The increases are expected primarily in NASA/DOD space programs—unless the Cold War should worsen. Under present circumstances, the Defense Department's budget is expected to level off at about its new record peacetime high of $51.6 billion.

• **Delayed-reaction spending**—Meantime, Federal spending on missile/space programs, although lagging considerably behind new money requests as it has over the last several years, is also expected to continue to climb sharply over the next several years.

For example, NASA is requesting a total of $3.7 billion in the new budget. However, the agency expects to spend only $2.4 billion in FY '63.

The same pattern is found in the Pentagon's budget estimates. The FY '63 request for new money is $51.6 billion; the spending forecast is $49.7 billion.

Differentials of this kind between authorizations and spending almost invariably result in considerable spending increases in successive budgets. Therefore, the new DOD/NASA money requests alone are considered certain to push spending in FY '64 beyond the $92.5-billion level at which the President hopes to balance the budget in FY '63.

The missile/space program requests for the new fiscal year show a number of decided trends:

—NASA, DOD and other space programs are claiming an increasingly larger share of the total appropriation slice. The new split: $5.5 billion for all space programs; $10.9 for missiles and related programs.

—Spending on big missile systems continues to dominate Pentagon procurement plans despite the buy-out of *Atlas* and *Titan I*. However, the procurement of tactical missiles as part of the strengthening of limited war forces is increasing significantly.

—The *Apollo* Manned Lunar Landing Program is maintaining its urgent pace, but it is narrowing somewhat in scope. Earlier plans for rapid development of a multimegapound-thrust solid superbooster have been dropped. (M/R, Jan. 15, p. 13). NASA will rely on reaching the moon by orbital rendezvous or using a liquid-fueled superbooster. Solid superboosters will be developed at a decidedly more leisurely pace.

—The number of new missile programs is growing smaller. The budget discloses emphasis on only two: The Air Force Mobile MRBM to be based on land or sea, and a new Army surface-to-surface missile for division support.

—Air Force space programs are increasing somewhat in dollars, but the increases could be far more significant than the dollars indicate. One of the most significant additions: sizeable funds for development of

(Continued on page 33)

missiles and rockets, January 22, 1962

Missile/Space FY '63 Budget Request

(NOA in millions of dollars)*

Missile Procurement	*4,011*
Missile RDT&E	*2,200*
Missile Base Construction	*650*
Military Sciences	*909*
Foreign Aid Missiles	*121*
Missile Maintenance	*1,300*
Ships (Polaris subs and seaborne GSE)	*1,500*
Other (Related military electronics, GSE)	*450*
NASA R&D	*2,667.5*
NASA Construction	*650*
Military Astronautics	*1,517.7*
AEC Astronautics	*192.9*
Weather Bureau Astronautics	*47.2*
NSF Astronautics	*1.7*
TOTAL	*16,218*

** Estimates based on official budget submissions*

DOD's $51.6 Billion Is a 'Plateau'

Barring drastic changes, pattern may be set through FY '67; stress is on ICBM's—little for military astronautics

PRESIDENT KENNEDY'S defense budget request for FY '63 is the first slice of an overall five-year military program that is expected to cost more than $260 billion.

This is the long-range significance of the $51.6-billion request for new defense money carried in the first Federal budget bearing the "pure Kennedy Administration" stamp.

In effect, top Pentagon officials regard the FY '63 new money figure as an "approximate plateau" that will be maintained through FY '67 unless there are sharp changes in the Cold War, major technical breakthroughs or unsettling political developments such as a change in Administration.

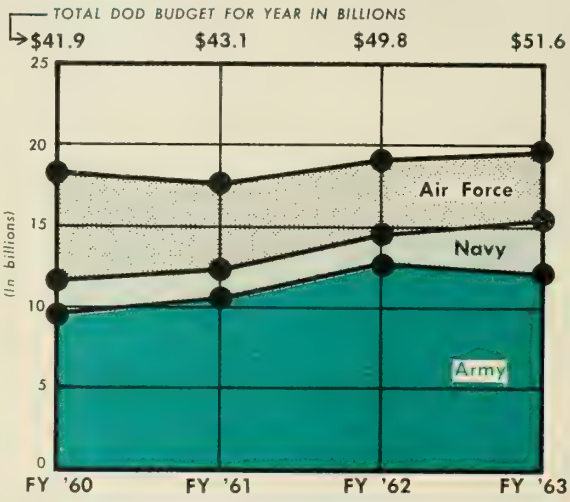
The putting together and adoption of the five-year defense plan is the result of the revolutionary changes in Pentagon budget-making introduced by Defense Department Comptroller Charles J. Hitch.

The new defense budget was sent to Congress in two forms: the first, the usual one, listed requests by appropriation titles as required; the second, by program packages, groups requests according to function and regardless of military service.

The program packages, in turn, were put together by the Defense Department in terms of the overall goals of the five-year program. Therefore, officials contend that they now can quickly determine the effect in dollars of any decision to change program packages or long-range goals.

Moreover, the new system is designed to switch the orientation of defense budget-making away from arbitrary dollar ceilings and toward security needs. Whether the new programs and the new plateau will harden into program ceilings and a roof is yet to be determined.

• **Break-down**—Under the new system, here is how the FY '63 budget breaks down into major military programs. The figures in billions of dollars represent the total amount of money the Administration plans to have on hand. Figures in parenthesis are for FY '62.



GRAPH OF four-year appropriations for three services shows continuing rise for all, consistent ratio of spending.

Strategic Retaliatory Forces	9.4	(9.5)
Continental Air/Missile Defense	2.1	(2.2)
General-Purpose Forces	18.4	(18.2)
Sealift and Airlift	1.3	(1.1)
Reserve Forces	1.9	(1.8)
R&D (not inclusive)	5.7	(4.7)
General Support	12.8	(12.1)
Civil Defense	.7	(.3)
Military Assistance	1.5	(1.6)
Pay Adjustments Proposed	.2	
TOTAL	53.9	(51.5)

The Administration proposes to meet the planned total by carrying over $2.3 billion in unused defense appropriations from FY '62 and receiving $51.6 billion in new money requested from Congress. This is $1.7 billion higher than the defense money request for FY '62.

Of the total $53.8 billion available, the Administration plans to spend $49.7 billion during the new fiscal year. This is $1.5 billion higher than planned spending during the current fiscal year.

By comparison, the Pentagon was spending at an annual rate of about $5 billion less during the last full fiscal year of the Eisenhower Administration.

• **No surprises**—As a whole, the new defense budget contained no big surprises in missile and space programs. Two noteworthy decisions—killing the mobile *Minuteman* and last-minute elimination of production money for the *Nike-Zeus* antimissile missile—had been known for some time.

Missile procurement requests soared to a total of $4.01 billion—some $750 million more than in the current fiscal year. Meantime, aircraft procurement requests, after a brief rise this year, dropped to a still-hefty $5.4 billion.

Military astronautics program requests rose somewhat to $1.5 billion, an increase of more than $350 million. The main space effort continued to remain in NASA's hands.

Here, area by area, is how the military missile/space programs fared:

Strategic Missiles

The Defense Department reaffirmed its decision to build an ICBM force capable of a more flexible strategy than the "all or nothing" plan of the Eisenhower Administration.

Both the *Minuteman* and *Polaris*

forces received new increases. U.S. deterrent strength in the later half of the 1960's is being staked primarily on the hardened and dispersed *Minuteman* and the mobile *Polaris*-launching submarine.

The budget seeks six more *Polaris* subs along with long-lead-time items for still another six. The new increase would bring to 35 the total number of fully funded ships in FY '63. The Navy also is seeking an additional *Polaris* tender—the fourth—and a converted cargo ship for servicing the tenders.

Moreover, funds are sought for the first time for initial construction of a *Polaris* Depot for servicing *Polaris* squadrons deployed in the Pacific. The depot is now scheduled to be built at the Bangor Naval Ammunition Depot, Wash., rather than Pearl Harbor as originally planned.

Despite the new requests for subs, the *Polaris* shipbuilding program is still slipping day-for-day beyond the 29th submarine.

The budget seeks four more 50-missile *Minuteman* squadrons, bringing to 800 the total force authorized or requested through FY '63. And officials confirm that plans call for at least several hundred more in FY '64.

However, there is no indication so far that additional sites beyond the bases for 800 missiles will be procured in advance in order to cut lead times if full *Minuteman* production should be ordered at a later date.

The programs for the nation's other two big strategic missiles—the *Atlas* and *Titan*—are nearing an end. The budget calls for final procurement funds to complete the planned 13 *Atlas* squadrons and six *Titan I* squadrons as well as "substantially complete procurement" of the planned six *Titan II* squadrons.

Initial procurement of the *Skybolt* ALBM also is to be ordered. However, this is merely for test missiles.

Tactical Missiles

Army procurement of tactical missiles will rise under the proposed budget plan. But the amount—$681 million—is still considered low for equipping the Army's strengthened ground forces.

Among the new missiles to be purchased are *Pershing, Davy Crockett, Sergeant,* and *Redeye*. Further buys are also planned for *Hawk, Honest John, Little John* and various antitank missiles.

The Navy plans to spend $772 million on missile procurement including the new *Subroc* underwater-to-underwater ASW missile. The buy also will include *Terrier, Tartar, Talos, Sparrow, Sidewinder. Bullpup, Zuni* and *Asroc.*

Under shipbuilding, the Navy's budget includes funds for the first nuclear-powered frigate to be equipped with the *Typhon* antimissile missile.

Military Procurement

(in millions of dollars)

		New Obligational Authority		Direct Obligations		Expenditures	
		FY '62	FY '63	FY '62	FY '63	FY '62	FY '63
ARMY	Missiles*	573	558	575	558	552	681
	Electronics/ Communications	307	278	314	291	190	235
NAVY	Missiles*	878	953	957	987	602	772
	Electronics/ Communications	391	360	434	378	266	333
AIR FORCE	Missiles*	1805	2500	2366	2550	2370	2446
	Electronics/ Communications	677	562	798	626	740	639

* Excluding construction, ships and maintenance

The Air Force tactical missile buy is to include *Sidewinders,* target drone missiles and *Bullpups*—both the A and nuclear B models.

R&D and Astronautics

The budget formally announced two new missile development programs. One is the Air Force mobile MRBM, which is to be designed for launching from land and sea. The other is a new Army surface-to-surface missile for division support, presumably the long-studied *Missile B.*

The budget also called for continued work on *Nike-Zeus, Skybolt,* the improved version of *Minuteman,* the 2500-mile-range *Polaris A-3, Typhon* and *Mauler.* Funds also were included for the B-70 bomber, *Shillelagh* and a number of more low-level projects.

In astronautics, the Air Force received most of the $1.5 billion sought for continued work, primarily on the *Samos, Midas,* and *Saint* satellite programs, the *Dyna-Soar* manned spacecraft and the new *Titan III* space booster. Air Force plans called for allotting about $40 billion to the development of the downgraded solid superbooster originally sought for the *Apollo* program's initial lunar trips.

The Army received funds for continued work on the *Advent* communications satellite; the Navy for the *Transit* navigation satellite system.

However, in general, the funding for military astronautics fell short of a number of proposals which many Air Force officials regard as urgent. ⌘

Military Research, Development, Test and Evaluation

(in millions of dollars)

		Total Obligational Authority		Obligations		New Obligational Authority	
		FY '62	FY '63	FY '62	FY '63	FY '62	FY '63
ARMY	Missiles	494.9	447	492	446		447
	Astronautics	88	100	87	100		100
	Military Sciences	228	183.2	228	185		183
	Total RDT&E*	1299.9	1329	1295	1334	1251.6	1329
NAVY	Missiles	682.7	671.8	605.7	670		672
	Astronautics	31.4	51.7	40.4	51.7		52
	Military Sciences	143.5	164.3	150.5	164		164
	Total RDT&E*	1306.3	1474	1398	1470	1296.2	1474
AIR FORCE	Missiles	1423.4	1304.1	1442.2	1269.9		1810
	Astronautics	940.4	1206.1	929.3	1175.7		1006.3
	Military Sciences	166.8	173.9	164.8	169.3		110
	Total RDT&E*	3350.1	3742.9	3351.2	3644.9	2434.4	3439
DOD	MILITARY SCIENCES	243.9	451	242	446	192	451

* Includes all other programs in addition to missiles, astronautics and sciences

Lunar Drive Gets $4-billion Push

NASA wins 100% boost over FY '62 request—mainly for Apollo, but Air Force gets top space-medicine role

by Hal Taylor

THE FIRST BIG downpayment for sending men to the moon is before Congress this week in the FY '63 budget.

The new Federal budget requests a total of $4 billion for civilian space programs. NASA's share—a whopping 100% increase over FY '62—is pegged at $3.7 billion. Well over $3 billion of this amount is earmarked for accelerating the *Apollo* Manned Lunar Landing Program, which is expected ultimately to cost $35 billion or more.

NASA's total budget breaks down this way in major new obligational authority:

—$2.9 billion for research, development and operation.

—$818 million for construction of new facilities.

In the other civilian programs, $192 million is asked for the Atomic Energy Commission's nuclear space systems and $47.2 million for the Weather Bureau's meteorological satellite system.

Moreover, the Administration also presented Congress this week with a supplemental request for $156 million to NASA's $1.7 billion FY '62 budget. All but $9 million will go into the lunar program.

The outlook for NASA next year: Considerably more.

As the new money bill went to Congress, NASA Administrator James E. Webb estimated the FY '64 request for his agency at substantially higher, but less than double this year's $3.7 billion. This would appear to indicate a total next year of $5.5 billion to $6 billion.

• **Spaceflight funding**—The FY '63 spending program earmarks $876.8 million for manned spaceflight—including both the three-man *Apollo* lunar craft and the two-man *Gemini* earth orbital vehicle. There is $747.9 million altogether for the *Saturn, Advanced Saturn* and *Nova* launch vehicles.

Other areas receiving major funding include lunar and planetary exploration, $273.5 million; scientific satellites, $175 million; liquid propulsion, $163.1 million; nuclear systems technology, $122 million; and tracking and data acquisition, $158.4 million.

The NASA budget breakdown was given by Webb, Deputy Administrator Dr. Hugh L. Dryden and Associate Administrator Dr. Robert C. Seamans, Jr. While there were no surprises or deviations from expected fund requests, the officials reported that:

—The solid *Nova* launch vehicle is now being developed strictly as a backup to NASA's large liquid vehicle (M/R, Jan. 15, p. 13). "There is no hope of getting it (solid *Nova*) ready in the same time period as the liquid vehicle. It has not been dropped, but there will be a year's further study of the problem," Dr. Dryden said.

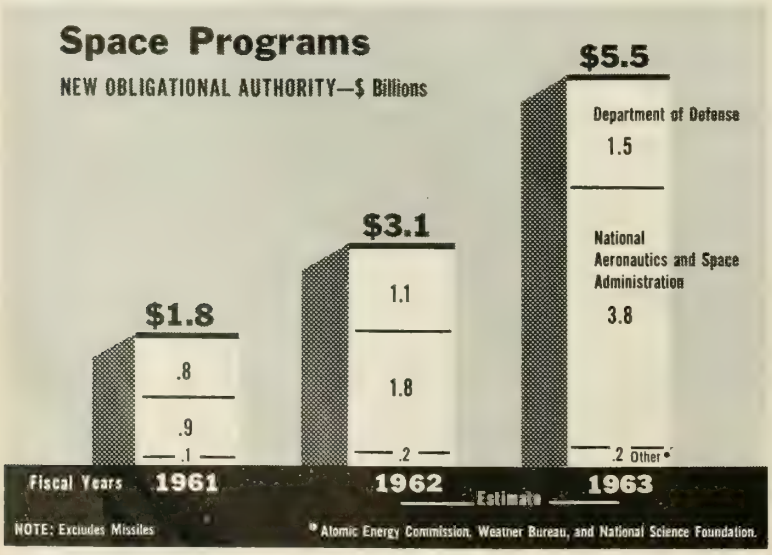
—NASA's Bioastronautics program will get only $27 million in new funds. This means that the Air Force has won the primary role and responsibility in space-medicine research for manned space flight. It has been learned from other official sources that this was the recommendation of the special Bioastronautics panel of the National Space Council.

NASA will prepare specifications and keep DOD informed as to the work it feels must be done. The Air Force will do most of the work, using its existing scientific complement and facilities. More of DOD's medical research funds will be poured into the space medicine area. NASA will get no funds to build new bioastronautics facilities other than those planned for the manned spacecraft center at Houston.

—A contract for the development of the M-1 liquid hydrogen-oxygen engine will be awarded in two weeks. Total funds requested for the program include $55 million in the Fiscal '63 budget and $26 million in the supplemental '62 request (M/R, Jan. 1, p. 10).

—A budget request of $163.5 million will be used for the design and development and the awarding of contracts for the first and second stages of the *Nova* liquid vehicle. The first stage of the vehicle will be powered by eight F-1 engines developing 12 million-lbs. thrust, the second stage will have four M-1 engines with a thrust of over 4 million lbs., and the third stage will have one M-1 (M/R, Jan. 8, p. 13).

—Design and development of the *Voyager* and *Prospector* spacecraft will begin in Fiscal '63 (M/R, Aug. 14,



1961, p. 37).

Voyager will be used for long interplanetary missions and is scheduled to orbit Mars. *Prospector* will be soft-landed on the moon and will provide support of manned lunar landings and exploration of the lunar surface.

—Development of follow-on active communication satellite programs similar to projects *Relay* and *Syncom* will begin and contracts are expected to be awarded to industry early next fiscal year (M/R, Aug. 21, 1961, p. 17).

—A new program is being launched to develop a high-power nuclear SNAP engine for application to large communication satellites, reconnaissance systems and space probes. The program will use basically the technology to be developed from the high-temperature lithium-cooled reactor experiments. Funds for the new program are included in the $71 million requested for research and development of nuclear satellite systems for the AEC.

The $2.9-billion total for NASA's research and development activities is misleading, because the general category also includes salaries, purchases of supplies and other supporting activities. The federal budget reveals that only about $2 billion will actually be spent on R&D by NASA. Some $400 million will be spent for NASA by other federal agencies. The remaining $500 million is the estimated costs of all the activities which support the space agency's programs.

Of the total of $3.9 billion in requested obligations, about $3.4 billion will ultimately be spent with industry. Only $2.4 billion will be spent by NASA in Fiscal '63. The remainder of the authorized funds will be doled out over a three-year period.

The major emphasis given to the manned lunar landing program is illustrated in the detailed breakdown of the budget provided by the three NASA officials:

• **Manned space flight programs**—A total budget of $1.6 billion has been requested. Funds for development of the *Apollo* spacecraft total $617 million, most of which will be used to finance contracts for the lunar-landing, command and service modules and an industrial contractor or contractors for the guidance system. Dryden said that the orbital laboratory module is still in NASA long-term planning but will not be funded in Fiscal '63.

A budget of $203 million has been asked for Project *Gemini*. This will pay not only for part of the development of the two-man spacecraft, but also for the *Titan II* launch vehicles which will be used in the program.

Project *Mercury* is slated to be

(Continued on page 33)

NASA FY 63 Construction Programs

(In Thousands)

	FY 61	FY 62		FY 63
		Appropriated	Proposed Supp.	
Ames Research Center	$ 980	$ 6,115	— —	$ 14,439
Atlantic Missile Range	27,546	72,225	$ 55,000	359,963
Facility Planning and Design	— —	5,154	— —	10,000
Flight Research Center	— —	— —	— —	1,807
Goddard Space Flight Center	9,500	9,180	— —	23,780
Jet Propulsion Laboratory	8,531	3,580	— —	10,360
Langley Research Center	11,957	6,530	— —	8,092
Lewis Research Center	9,590	1,040	— —	43,833
Manned Spacecraft Center	— —	60,000	— —	30,755
Marshall Space Flight Center	26,208	25,716	— —	33,437
Michoud Plant	— —	980	— —	34,500
Mississippi Test Facility	— —	10,090	16,000	92,500
National Nuclear Rocket Development Facility	— —	15,000	— —	40,000
Pacific Missile Range	— —	995	— —	— —
Various Location:				
Manned space flight control centers	— —	— —	— —	18,000
Propulsion Development Facilities	— —	24,025	— —	45,000
Sounding rocket facilities	— —	500	— —	— —
Space Radiation Effects Laboratory	— —	— —	— —	12,382
Tracking facilities	28,235	20,261	— —	35,850
Wallops Station	3,750	7,965	— —	4,300
TOTAL APPROPRIATIONS	$126,297	269,356	$71,000	$818,998

NASA Research, Development and Operations

(In Thousands)

PROGRAMS	FY 61	FY 62	FY 62	FY 63
Mercury	$124,330	$ 68,278	$	$ 13,259
Advanced Manned Space Flight	6,266	147,242		863,628
Saturn C-1	173,908	282,193		249,237
Advanced Saturn	623	27,762	50,000	335,172
Nova	297	6,322		163,574
Meteorological Satellites	19,610	54,310		51,185
Communications Satellites	33,833	48,477		85,377
Sounding Rockets	12,330	14,261		19,157
Scientific Satellites	54,398	117,618		175,165
Lunar and Planetary Exploration	91,019	169,964		273,560
Scout	9,652	8,206		8,947
Delta	10,479	2,927		268
Centaur	64,673	65,840	9,000	66,664
Spacecraft Technology	27,126	37,145		54,084
Launch Vehicle Technology	13,851	23,080		31,690
Launch Operations Development	100	1,789		21,486
Electric Propulsion	7,164	17,581		30,647
Liquid Propulsion	72,726	103,901	26,000	163,102
Solid Propulsion	1,899	4,297		7,944
Space Power Technology	8,913	14,644		20,172
Nuclear Systems Technology	25,050	50,234		122,962
Aircraft and Missile Technology	37,857	41,479		52,588
Tracking and Data Acquisition	44,330	94,844		158,410
TOTAL PROGRAM	$840,434	$1,402,394	$85,000	$2,968,278

Backups scheduled . . .

Ranger III: Most Complicated & Promising

NASA IS READY to attempt its first long space flight with mid-course and terminal guidance—the hard-landing of *Ranger III* on the moon.

The flight—scheduled for a Jan. 22-26 window—will be by far the most complicated unmanned experiment ever undertaken by the United States. It also holds promise of being the most rewarding scientifically.

If successful it will provide the first televised "close-up" photographs of the moon and the first recordings of seismic activity and other information about the structure and composition of the lunar surface. (Russia's *Lunik II*, which impacted the moon in September, 1959, released only a sodium vapor cloud. It contained no known experiments and took no pictures.)

Ranger III, moreover, is the forerunner of a series of increasingly sophisticated vehicles intended to explore and stake out a landing site for the first U.S. manned lunar expedition.

The intricacy of the mission, involving dozens of perfectly timed events, has left little room for optimism. Indeed, NASA says it has scheduled two backup shots this year "in the hope that one of the three will be successful."

Adding to the uncertainty is the failure of two previous *Ranger* launches designed to simply fly long elliptical earth orbits. In both of these, the *Agena B* vehicle failed to push the spacecraft out of its near-earth orbit into escape velocity.

• **Flight program**—During its 66-hr. flight to the moon, the 727-lb. gold- and silver-plated spacecraft carrying a balsa-wrapped impact capsule will follow this program:

—Leave the earth (on an *Atlas-Agena B*), achieve a parking orbit and reach escape velocity of 24,500 mph.

—Perform a three-axis maneuver in space to lock onto the sun and the earth.

—Accept correction commands from the earth, change its orientation in flight, and fire a mid-course motor to put itself in collision course with the moon.

—Re-establish its lock on the sun and the earth.

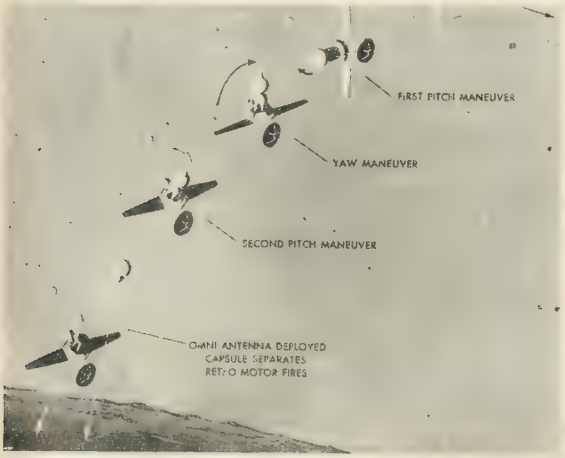
—Perform a terminal maneuver when it gets within 5000 mi. of the moon.

—Take television pictures of the lunar surface as it approaches the moon and make studies of the composition of the lunar surface and its radar reflection characteristics.

—Separate a retro rocket and capsule system from the spacecraft when it is 70,000 ft. above the lunar surface.

—Fire the retro rocket to slow the capsule system from 6000 mph to zero velocity 1100 ft. above the surface.

—Detach the instrumented capsule containing a seismometer from the retro rocket so that it rough-lands from a free fall of 1100 ft., survives the landing, positions itself, and then sends back to the earth for 30 days information on lunar shock waves and meteoritic impact.



TERMINAL MANEUVERS of Ranger III shown for first time in NASA artist's conception

Ranger III is 5 ft. in diameter at the base of the hexagon and in its launch position with the solar panels folded up in the manner of butterfly wings. In that position, it is 8.25 ft.-high. In the cruise position, with its solar panels extended and the high-gain directional antenna in its extended position, it is 17 ft. in span and 10.25 ft. high.

The *Atlas* booster will carry the *Agena B* and *Ranger III* to an altitude of 115 statute miles above the earth and to a velocity considerably below orbital speed of 18,000 m.p.h.

At approximately 280 seconds after launch, the *Agena* fires for the first time to reach orbital speed. It will then shut down and go into a parking orbit for more than 13 min., until it reaches the optimum point in time and space to fire for the second time.

This firing, which will put the spacecraft into escape velocity, will occur over Ascension Is. in the South Atlantic approximately 23 min. after launch.

Four hours after launch, the gamma-ray experiment will be turned on.

This is a spectrometer contained in a 12-in.-dia. ball mounted on a 40-in.-long arm on the hexagon.

At the same time, a spring-loaded radar antenna is moved out so that it can send its radar pulses to the lunar surface. This will test the radar reflectivity. It will view an area approximately 60 sq. mi. or less of the lunar surface; the result may serve to establish a standard area of calibration for more complex earth radar systems to use in lunar work.

As the radar antenna is moved out, a lid covering the camera lens is pulled back. At 2400 mi. from the surface of the moon and 40 min. before impact, the camera with its telescope starts taking pictures of the lunar surface, transmitting them every 30 sec. to Goldstone Deep Instrumentation tracking station.

The radar altimeter—ranging its signals against the moon surface—initiates the next command. At 8.1 sec. before the main spacecraft is due to crash into the moon and destroy itself, the lunar capsule is jettisoned.

The retro rockets fire for ten seconds and cancel out approximately 6000 mph from the speed of the capsule assembly. Retro rocket ignition is initiated at 52,000 ft. so that the entire assembly will come to zero velocity when it is approximately 1100 ft. from the lunar surface.

The capsule is expected to impact at 150 mph. ⌗

Safer Sea Recovery Planned for Glenn

A NEW WATER recovery system will be employed on the *Mercury* capsule when the United States makes its first attempt to send a man into orbit.

The new system is designed for greater safety in the open sea. Its main feature is an inflatable rubber ring to keep the capsule upright (see photo) and avoid a possible repetition of the near-drowning of Astronaut Virgil I. Grisson in *MR-4* last July (M/R, July 31, p. 16).

Marine Corps. Lt. Col. John Glenn, Jr., is to be at the controls of the Friendship 7 *Mercury* capsule as this country tries to duplicate the Russian feat of manned orbital flight achieved last April and again in August.

Earliest date for the launch is Jan. 24, but space agency officials said that slippage from day to day is possible.

Also undecided is how many times *MA-6* will orbit the earth. The decision as to one, two or three orbits will not be made until moments before blastoff, and it can be changed any time during the mission.

The Soviet flights were for one and 17 orbits' duration. NASA will not attempt an 17-orbit flight until later this year, using a *Mercury* capsule with a modified life support system.

• **Similar capsule** — *MA-6* is designed to prove that manned orbital flight with the *Mercury* capsule is possible; it will be essentially a repeat of *MA-5* with a chimp aboard last November. It will also provide necessary information for later flights in the two-man *Gemini*—the *Mercury* follow-on—and three-man *Apollo* lunar spacecraft.

Friendship 7 will be launched with an *Atlas* booster into an earth orbit ranging from 100- to 150-mile altitudes. Each orbit will last 90 minutes, with top velocity of 17,500 miles per hour.

The *MA-6* capsule will be similar to those used in earlier Project *Mercury* flights. It will weigh 4000 lbs. at takeoff, 3000 lbs. during orbit and 2400 lbs. when it is recovered.

If a one-orbit flight is made it will last 1¾ hours with recovery 500 miles east of Bermuda; two orbits, 3½ hours with recovery 500 miles south of Bermuda, and a three-orbit flight, 4¾ hours with recovery 800 miles southeast of Cape Canaveral.

The new recovery system is the only major change from earlier flights.

NEW ESCAPE SYSTEM employing flotation ring and frogmen will be used in manned Mercury orbital flight. Running the test here is Astronaut Alan Shepard.

• **Enter frogmen** — The astronaut will probably leave the capsule by the neck rather than the side hatch that was used during the manned suborbital tests. When he does, he will be met by two frogmen, who by that time will have cinched the new flotation belt around the base of the craft. The technique follows one suggested for recovery with a blimp (M/R, Aug. 7, 1961, p. 17).

Frogmen will leap into the water with the quick-inflation belt from one of several recovery helicopters—launched from aircraft carriers—in the landing zone. As soon as the three-foot-high belt is secured, the astronaut will emerge, grasp a horse collar from a hovering helicopter and be hoisted about for the flight to a nearby carrier. A smaller ship will recover the capsule and the frogman.

During the flight, Glenn or the backup astronaut, Navy Lt. Cmdr. Malcolm Carpenter, will be kept busy by a long string of duties including monitoring the spacecraft's attitude control, electrical, environmental control and communications systems.

He also will monitor critical events during launch and terminate the mission if necessary.

His other chores will include:

—Maintaining a complete navigation log during flight which will enable him to compute his retro-fire time if ground communication should fail.

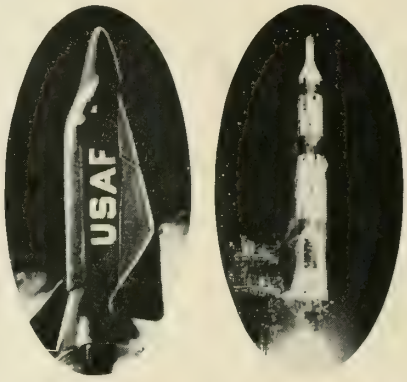
—Sending to ground communications updated retro-fire information and details of reports on behavior of spacecraft systems as determined by ground telemetry.

—Evaluating his physical condition to augment telemetered data.

MA-6 will carry about 3000 calories of beef mixed with vegetables and about 6 lbs. of water. The water will be in two flat bottles each fitted with an extendable tube. The food will be in two tubes about the size of toothpaste containers. There will also be quick-energy sugar tablets.

Because of the number of possible recovery areas, more than 20 ships will be deployed in the Atlantic alone. In addition, ships and rescue planes around the world will go into action in event of an emergency landing. More than 15,000 men will have a hand in the recovery, search and rescue effort. ⌘

MILITARY SPACE SYSTEMS



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ISSUE: MARCH 26, 1962

ADVERTISING CLOSING DATE: MARCH 5

Technical Countdown

ELECTRONICS

Mono-Degree ComSat Gyro Envisioned

A single gyro-skewed axis concept could stabilize a communications satellite with its radio antenna permanently pointed towards earth. The MIT idea combines the gyroscopic reaction of a satellite with that of a single gyro to achieve relative precession of the vehicle and the gyro's gimbal. The oscillatory energy of the vehicle would be dissipated as heat in the viscous damper of the gyro. Key to the concept is the tilt in the reference axis of the gyro and in the radiation axis of the antenna relative to the principal inertia axis of the satellite.

Apollo May Use Fuel Cells

Fuel cells seem to have the inside track in the running for *Apollo* power supplies. Word is that a NASA development contract in the area is imminent. Most likely contenders include General Electric, Pratt & Whitney, Union Carbide, Allis Chalmers and Thompson Ramo Wooldridge.

Maser Cooling Through Closed Loop

Garrett's AiResearch Division is developing a two-loop maser cooling system using neon and helium. Conventional cascade, piston expanders will be replaced by turbomachinery. Both expander and compressor will be completely nonlubricated, the former using gas bearings and the latter dry bearings.

Lunar Navigation Progressing in USSR

Charts of the sky as seen from the moon and the planets in the Solar System are being compiled by the Commission for Lunar Research of the Soviet Academy of Sciences. The charts would be a necessity for prolonged lunar exploration.

High-Strength Superconductors Can Be Predicted

Research in molybdneum-rhenium has led Westinghouse scientists to a rule-of-thumb formula for predicting which superconductors will reach high magnetic strengths. Very strong fields observed in high-field superconductors can be approximated by multiplying the measured field in bulk, unworked material by a factor of 30. The ratio holds for all known high-field super-conductors.

PROPULSION ENGINEERING

Rocket Test Station Open to Industry

General Electric is making the Malta Test Station near Schenectady available to industry on a service basis. The facility is one of the few in the East capable of handling rocket engines up to 250,000 lbs. thrust, liquid-propellant evaluation and environmental testing. Current programs at the station involve Lockheed, Marquardt, and GE's MSVD.

ADVANCED MATERIALS

Minuteman Memories Produced at Sperry

Magnetic-free disk memory units for the *Minuteman* will be produced by Sperry Gyroscope Co. under a contract from North America's Autonetics Division. Sperry will use Autonetics-developed computer techniques and manufacturing processes in order to have completely interchangeable memory units. Initially, only subassemblies will be handled; later, Sperry will take charge of procurement or production of all required components.

Commercial Process Fallout Studied

Industrial economists at the University of Denver will trace technological advances generated by the various space programs as they filter into commercial use. Under a $56,745 NASA contract, the group will investigate means to enhance this flow and also to attempt a forecast of future civilian products which may result from current space research.

Beryllium Composites for Re-Entry

Aeronca Manufacturing Corp. is developing capability to fabricate insulated sheet beryllium-ceramic composite, with an eye toward re-entry and space vehicle structures. Under a $1.2-million AFASD contract, the work also calls for optimization of the heat-sustaining structure, and a new structural insulation system has been developed. A full-size test section of a representative lifting body re-entry vehicle will be delivered to Wright-Patterson AFB for evaluation.

Scandium Similar to Yttrium

Analysis of the first pound of scandium ever produced indicates the element's properties are very similar to those of yttrium and somewhat similar to titanium's. Measurements made by Union Carbide scientists included the metal's crystal structure, density, resistivity, thermal expansion, tensile and compressive strengths and reaction data.

Titanium Weakens at Cryogenic Temperatures

Battelle researchers have confirmed the theory that the relative toughness of titanium falls off at near-cryogenic temperatures as oxygen concentration increases. Notched-unnotched strength ratios were measured with alloys Ti-6A1-4V and Ti-5A1-2.5Sn. Other tests checked direction, yield and tensile strengths, elongation and notched-unnotched strength ratios.

SUPPORT EQUIPMENT

Sun Will Have Earthbound Rival

General Electric's new Space Technology Center at Valley Forge, Pa., will include a space simulator capable of creating the severe environment of the exosphere. Measuring 54 ft. high x 32 ft. in diameter, the massive facility will be capable of producing a near-vacuum at about −280° and of training a 20-ft.-dia., 18,000-footcandle beam of light on test vehicles. Four banks of 37 xenon-arc floodlights each will be focused through a giant lens and reflector assembly. Although the new lamps operate at 35 v., 145 amp., a 50,000-v. pulse is required to develop the arc across lamp electrodes.

System Yields Fine Sea-Floor Maps

by William Beller

A RECENT ADVANCE in underwater photography may lead to large-scale "aerial" surveys of the sea bottom by ship-mounted or ship-towed cameras.

The new technique produces color stereoscopic pictures that are turned into topographical maps of micro-areas of the ocean floor.

These maps give remarkable delineations of the character of the floor, which become valuable data in a "sonar bounce" system used to detect submarines.

An extension of the technique is proposed as an effective way to search out and classify mines.

Oceanographers also see high value in it for tracing the flow of ocean currents, learning the geology of the ocean bottom, and studying the sea's organisms.

The Coast and Geodetic Survey (C&GS) is pioneering work on underwater stereoscopic photography, the Hydrographic Office has made experimental runs with stereoscopic equipment, and the Office of Naval Research is said to be evaluating the concept for defense applications.

• **A wide-eyed camera** — Heart of the system are two cameras spaced five feet apart—rather than the "eye-span" distance of 2.5 in. In this way, parallax is sufficiently increased to give accurate readings of terrain heights. This method has been used in aerial photography but not, until now, in underseas work.

FRAME carrying the stereoscopic camera system is lowered over the side.

Biggest stumbling block in the way of taking underwater color pictures for topographical purposes is getting enough light to illuminate deep-sea terrain. The sun's light is gone at about 500 ft. below the water surface, which means that other methods have to be used to make the floor visible.

Dr. Harold E. Edgerton, inventor of the electronic flash, proposed that a pulsed light be used—a technique based on his earlier development. And he supplied a basic system to C&GS through Edgerton, Germeshausen and Grier Co. of Cambridge, Mass. In turn, the C&GS modified the system into its present one.

In addition to two cameras, the system has two light sources, a sonar "pinger" and a power supply. The components are separately housed in cylinders able to permit operation at depths down to 37,000 ft. These are "bathyscaphe" depths, and an unmanned instrument that can work at them has the immediate advantage of economy.

• **A peep at the deep**—The cylinders are mounted on a framework lowered from a ship into the sea.

As the apparatus sinks, the sonar pinger generates a signal sent both downward and upward. The direct signal plus the one reflected from the ocean floor are displayed on a shipboard oscilloscope, and the phase difference between the two tell the apparatus' approximate height above the floor. A timer puts the system into operation when it is at the chosen distance above the ocean floor, usually from 10 to 25 feet.

(When the stereoscopic photographs are developed and analyzed, the exact height of the apparatus above the sea floor is determined.)

The camera lens is opened and kept open since there is no ambient light at the operating depth. A frame of film is exposed each time the electronic flash pulses—once every 14 seconds, which is the recycling time of the capacitors. Each light gives out 200 watt-seconds of energy.

After each flash, the 35-mm film in each of the cameras is driven to the next frame until 500 frames are exposed—the system's present capacity.

In the system's first tests, color stereoscopic photographs showed sea life at 2000 ft. and bottom formations at more than 7000 ft. Each slide caught a view of about 65 sq. ft. of ocean bottom.

About 1000 slides were made by the new camera. With these, C&GS photogrammetrists prepared the first "micro-topographical" map of the ocean floor. This remarkable little map, covering 12 sq. ft. of ocean bottom, shows ¼-in.

STEREOGRAPHS of three organisms in the deep sea. A three-dimensional effect can be experienced if each picture is individually seen by each eye. This can be done by running a strip of cardboard two to three feet long from the white strip between the pictures to the tip of the viewer's nose.

contour lines for elevations ranging from zero to three inches.

Although the camera is used to take photographs of only small areas of sea bottom, C&GS scientists explain that these bottom "samples" provide a precise idea of what the sea floor in general is like.

"I wouldn't be at all surprised if this is only the first step," Dr. Harris B. Stewart, Jr., C&GS's chief oceanographer, told MISSILES AND ROCKETS. Warming up to the idea, the scientist added, "Eventually, we'd like to run 'flight strips' from San Francisco to Honolulu. Now that we see that the ocean floor can be stereo-mapped—why, the sky's the limit, if you can use that expression."

The photographs now under study were taken 90 miles southeast of Nantucket, in an area along the continental slope known as "Hydrographer Canyon," named in the 1930's for a C&GS ship.

Next trials are scheduled for this spring at a depth of 12,000 ft. in the waters around Puerto Rico.

• **More light needed** — There are still major problems to be solved before the present system can be used on a wholesale basis. C&GS scientist W. D. Harris says that he'd like to have wide-angle lenses on the cameras but there aren't any around that will not be distorted by port windows, which are needed to resist the pressure of thousands of feet of water. Such lenses would make each photographic frame more efficient because it would "see" larger areas of the ocean floor.

An apparent answer is to raise the camera system higher above the floor. But then more illumination is needed, which is the second problem requiring a solution. The lenses in use have relative apertures of f4.5, and although they possibly could be made faster, this would not be nearly as effective as a high-powered lighting system could be.

The General Electric Engineering Laboratories in Schenectady, N.Y., recently completed a theoretical study of a deep-sea photographic system. To attentuate back-scatter of light by particles suspended in the sea water, G.E. scientists call for extremely short bursts of illumination—of the order of 10^{-8} seconds. Unlike the C&GS system, the GE system prescribes an image orthicon to pick up the signals, conceivably amplified by a ruby laser.

A GE engineer says that a rule-of-thumb limit places the camera not more than 1000 ft. above bottom terrain.

Although this estimate is the most conservative of several given to M/R, if it were realized it would surpass even aerial photography in its value to photogrammetry. ❖

"MICRO-MAP" derived from stereoscopic color pictures shows in the fine detail of ¼-in. contours the topography of an 18-by-30-in. area of the ocean floor.

Biggest Vertical Heat-Treating Furnace

120-ft.-high Pfaudler facility now being used for production can handle diameters of over 160 inches

by John F. Judge

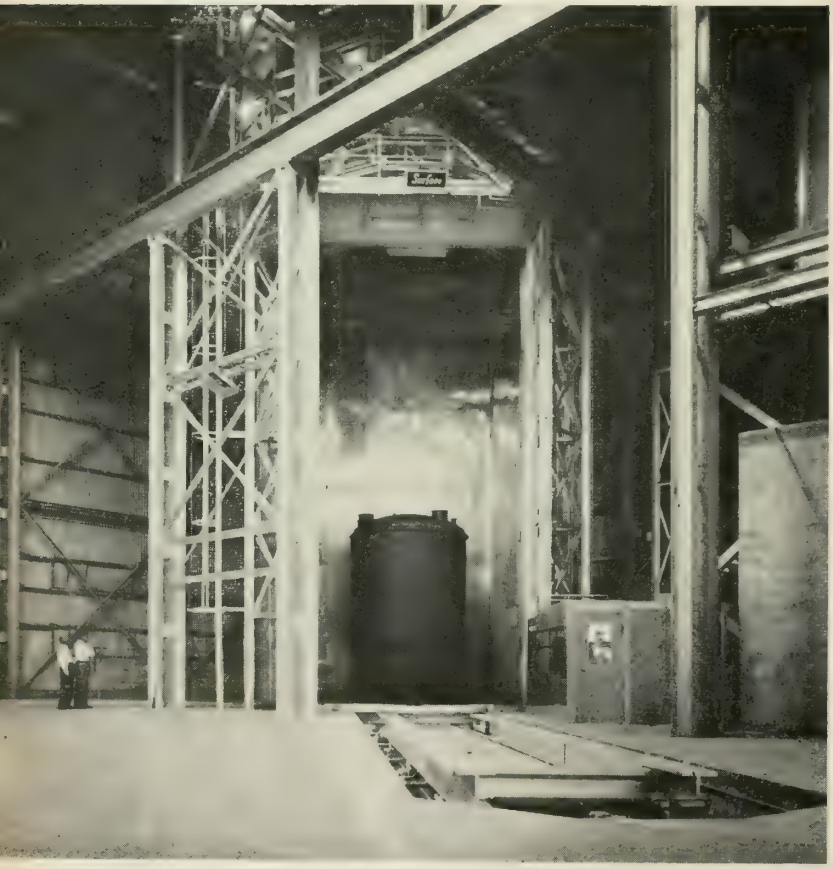
THE LARGEST vertical heat-treating facility in the world—capable of handling solid-rocket cases in excess of 160-in.-dia.—is in operation at The Pfaudler Co., division of Pfaudler-Permutit, Inc., Rochester, N.Y.

The installation expands Pfaudler's capability in its basic product line—supplying equipment for the processing industries—and puts the firm in the ranks of an industrial complex ready to tackle a big solid-booster program.

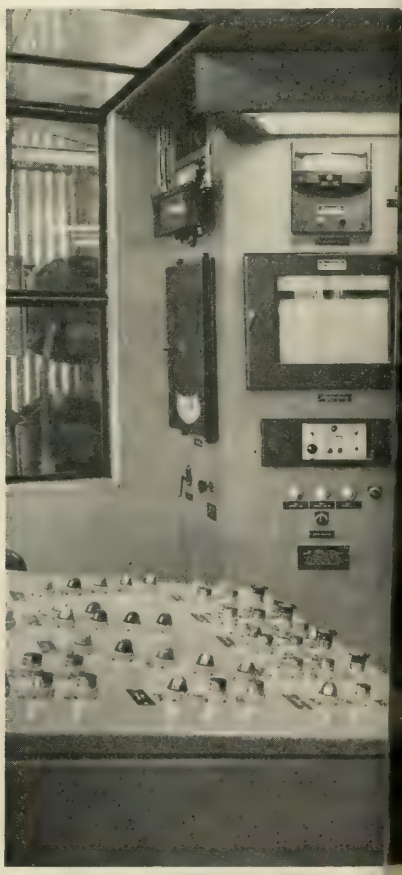
Overall, the permanent furnace structures towers 120 ft. The massive unit has inside dimensions of 17-ft. (204 in.) diameter and 33 ft. in height. The facility has been designed with structural clearances for a 40-ft. internal height accomplished by raising the arch.

The furnace is now in production use and provides missile/space programs with a heat-treating facility financed by a private firm on the basis of other product needs.

• **Excellent tolerance**—Designed for 2500°F constant service with 54 million BTU capacity, the unit can maintain



GLASSED-STEEL PRESSURE vessel rests in the loading bay of Pfaudler's huge heat-treating furnace. Cold vessel was placed on charger in foreground and moved onto elevator-hearth located beneath the furnace. Unloader at left removes tank to permit charging of the next unit.



AIR-CONDITIONED control cubicle is the monitoring station which handles all of the loading, firing, and unloading of pieces

± 10°F characteristics throughout its entire length. This is achieved through special linings of monolithic refractories, spirally located and tangentially oriented burners, plus excess air or ratio option and multi-zone controls.

The highly automated and instrumentated control system can vary the temperature from 400° to 2500° within small tolerances. Control equipment includes multi-zone thermocouples, for internal furnace temperature measurement, and radiation heads for measurement, automatic control and recording of actual work temperatures.

A programer, integrated with the electronic system, permits reliable preselection of heating rates, holding times and cooling rates. The furnace is designed for inert atmosphere.

• **Bottom loading** — The variable-speed rotating hearth of the furnace combined with high operating temperatures necessitated the design of a special seal closure. Other features include a variable-speed loader, unloader and elevator mechanism. All of these are automatically controlled, and the circuitry is interlocked for maximum reliability and safety.

The huge furnace is fixed—any quenching tanks needed are rolled under the unit to accept the treated part. The design of these quench tanks and other accessories for heat-treating solid cases is complete and installation can be accomplished within 90 days of go-ahead signal. A case can be either hung in the furnace or bottom-supported—or both.

Pfaudler's location is accessible to several modes of transportation. The plant is 75 ft. from the New York State Barge Canal, three miles from Lake Ontario—which serves as a route to the Saint Lawrence Seaway or other Great Lakes—and near railroad facilities.

The furnace building itself houses a 50-tone crane, automatic dust collectors and independent heating, air, water, gas and electrical systems. Special projects can easily be confined to this self-contained area, since railroad siding adjoin the new 20,000-sq.-ft. building.

Pfaudler has long specialized in pressure vessels, large and small. The firm has fabricated thousands to ASME standards and former API codes. Heat-treating and quenching of pressure vessels and other products of varying materials are routine in the many furnaces in the firm's two plants.

Research into the techniques of support materials during heat-treat and handling methods is going on constantly. Large units are common, and trained personnel are familiar with handling problems.

The new, vertical furnace was developed, designed and installed over the last three years to provide support for existing government contracts on silicide coatings, solid-fuel propellants and to make possible the firing of up to 30,000-gal. glass-lined reactors and vessels for the processing industries.

The firm has also developed a pack cementation coating process for the re-entry oxidation protection of molybdenum structural parts for aerospace vehicles. This was done under an Air Force contract. ⁂

to be treated. All furnace operations are controlled from this booth, and all controls are interlocked for reliability and safety.

ELEVATOR-HEARTH in place at base of furnace. The closure utilizes a special seal to isolate the furnace interior. For motor cases, a shroud would cover the vessel while in the furnace to provide the inert atmosphere. Quench tanks can be rolled under the unit to accept treated motor chambers.

AF Lectures Cover Host of Lunar Problems

by Heather M. David

SAN ANTONIO—Radiation protection may be a "bone-chilling" experience unless a way can be found to predict solar flares.

Conferees at the Air Force's Lectures in Aerospace Medicine were told by Prof. C. A. Sondhaus, U. of California, of several novel ways of protecting against radiation damage.

One method he suggested would be to make use of the reduced air pressure (about ⅓ atmosphere) in which U.S. spacemen will probably have to operate. He said that a state of anoxia (oxygen starvation) might be of some use in protecting against radiation.

Another possible deterrent to radiation damage might be diet. Unsaturated fatty acids have been shown to be effective protection against radiation at sub-lethal levels. On a flight of long duration, he said, careful diet might aid in minimizing radiation damage.

Injection of bone marrow is also known to be effective in increasing radiation tolerance. The UC paper quoted the proposal that frozen and shielded bone-marrow suspensions might be taken from each potential astronaut for use in emergency situations on the voyage.

• **Man on the moon**—Dr. Hubertus Strughold, professor of space medicine and advisor for research for the Aerospace Medical Center, outlined some of the unique biophysical problems of travel to the moon.

Since the magnetic field of the moon is 400 times weaker than that of the earth, all types of radiation found in space have direct access to its surface—and in the primary form in which they are found in space.

Additionally, the moon may have a dense electronic layer up to one meter, with 100,000 to 1,000,000 electrons per cm^3 above the moon's surface blending at about 15 meters within the general electron density of space. This theory was advanced by Prof. Fred Singer and Dr. F. H. Walker. If it is correct, the moon astronaut would be in an environment medium similar to that of the F-layer of the earth's ionosphere.

The moon is generally assumed to have very tenuous atmosphere, if any at all. Dr. Strughold pointed out that an unprotected body would experience the same reaction as it would to an earth altitude of 63,000 ft. This would include profuse evaporation or boiling of body fluids, and a "time reserve" of less than 15 seconds after exposure.

The chance of meteoritic impact will be basically the same as in free space, except that it is cut to one-half that value by the moon's solid body itself.

The environment for the ear would be the "silence of space" with all its psychological implications.

There will be a permanently black sky—since there is no atmosphere to diffuse or scatter light. The stars and the sun will shine much more intensely, and at the same time.

Looking directly into the sun will be very hazardous. The retinas can be severely burned, as in an atomic flash.

The day-night cycle on the moon is 27 days duration, half of which is continuous sunlight. Thus the day-night cycle cannot be used to regulate sleep and wakefulness.

The sun will be a rich source of energy, invaluable in the photosynthetic regeneration of the environment. However, it will be absent for half the time, and nuclear power must be used.

At some depth the soil may be permanently frozen, or there may even exist a layer of frozen water at a depth of about 30 meters. This would be tremendously valuable for a life support system.

• **Moon-microclimates**—Dr. Strughold also noted that there will be small pockets of unique climatic conditions below the rims of craterlets, cliffs, rills, ridges and in caves. He said these locations would provide some thermal stability and a shield against meteoritic material and cosmic rays. If primitive life exists on the moon, it will probably be in these microclimatic niches.

Lunar gravity is about 17% that of the earth—probably just enough to permit walking. According to Dr. Strughold, this should decrease metabolic turnover, and caloric intake can be cut down to about 2500 to 2800 per day. He cautioned scientists not to go too far in that respect because decreased weight and resultant hypodynamic state might lead to a kind of general asthenia affecting the muscles and the circulatory system. Physical exercise will be a must.

• **Extraterrestrial life**—If life resembling that on earth does exist on other planets, there is a fifty-fifty chance that it may not be edible or usable to earth-originated beings.

Dr. Stanley L. Miller, of the University of California, San Diego, told of an experiment in which he synthesized amino acids from conditions like those of the earth billions of years ago. Although amino acids are a long way from being proteins, he said this was a first step proving that life originated spontaneous in the earth's oceans.

Amlyno acids occur in two forms—identical in their construction but "mirror images."

Most earth biologic forms are "righthanded"—or L—amino acids, and cannot utilize lefthanded—or D—amino acids for food.

Dr. Miller found that the two forms synthesize in equal parts, and he said it was probably by chance and natural selection that one form dominated the other on earth. He said that it might be equally possible that the other form might be predominant on another planet. Thus, although its plants and animals might look exactly like those on earth, they might be indigestible or even toxic.

• **Biological dosimeter** — The Air Force also presented results of its *Discoverer XVII* and *XVIII* flights, in which it tested a dosimeter to determine the damage potential of radiation.

Air Force microbiologists found that clostridium spores would mutate at a roughly predictable rate when exposed to certain dosages of radiation. A number of capsules of clostridium were carried in *XVII*, which was exposed to a solar storm.

All the capsules showed effect of exposure to radiation, in varying degrees relative to their position in the capsule.

About a week later *Discoverer XVIII*, with duplicate experiments, was launched. Although most of the solar flare had passed, there was still a greater amount of ambient radiation than is normally present. Again, results were borne out and the capsules showed the same relativity.

In all cases, the microbiologist said, the samples did not appear to have received more dosage than a human being could easily tolerate. ⁂

Zeus May Get Array Radar System

Sylvania wins Army award for further work on design which would replace larger acquisition units now used

by James Trainor

A MAJOR change may be in the offing for the Army's *Nike-Zeus* anti-missile missile system.

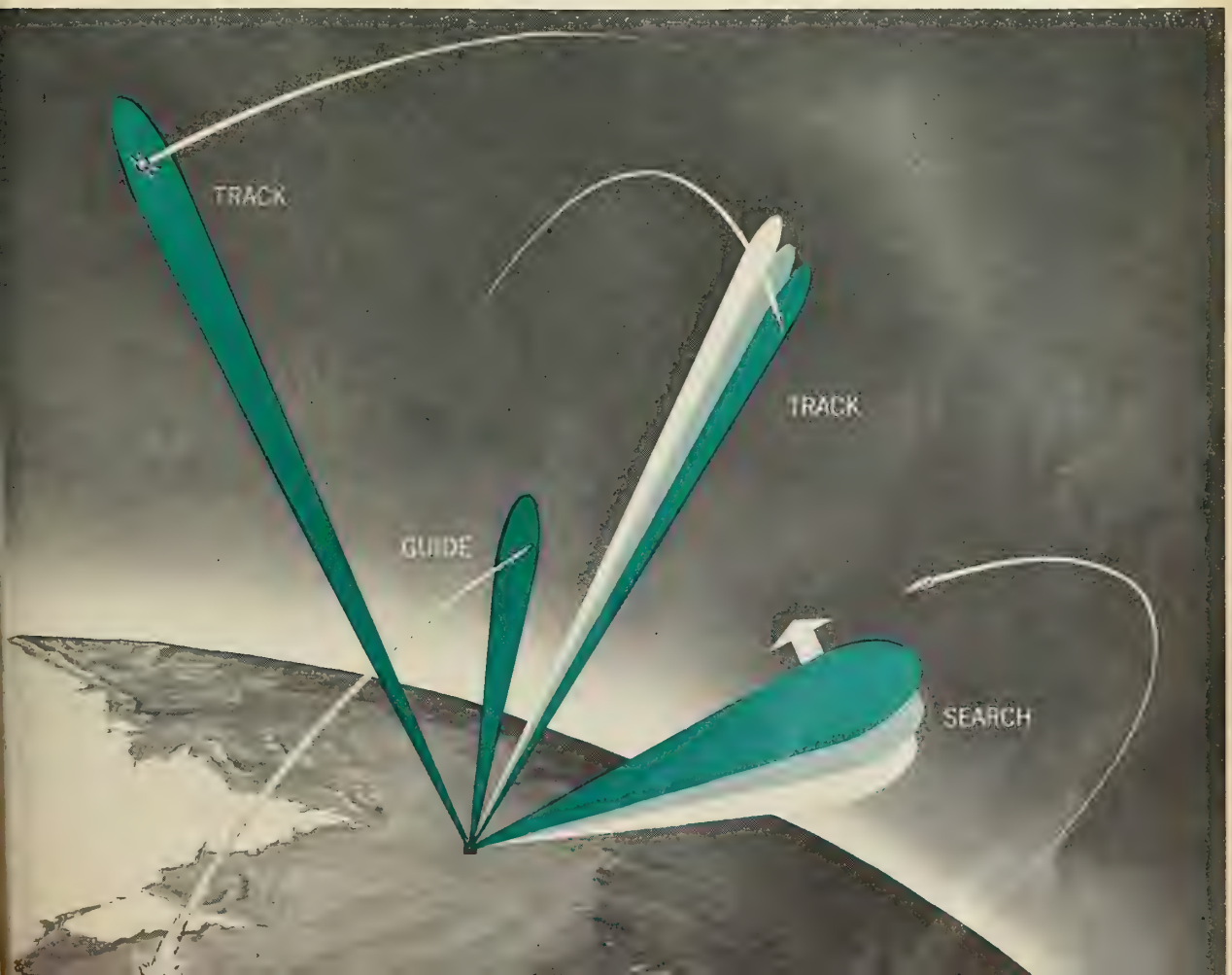
This was revealed last week in a $28-million award to General Telephone & Electronics Corp., Sylvania Electronic Systems division "for continued development of an advanced radar design for possible incorporation" into the Army system.

Already termed ZMAR, for *Zeus* Multi-function Array Radar, the system consists of an electronically-scanned antenna designed to search large areas of space and to detect, track, and identify enemy ballistic missile warheads.

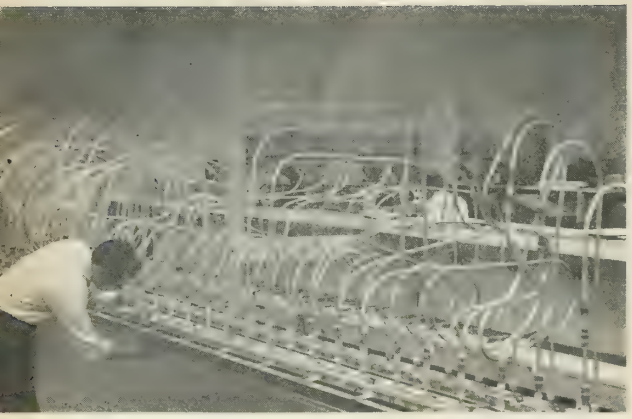
Although most of the information concerning the project is highly classified, it was announced that the contract calls for the design and delivery of a reduced-scale model of the radar to the White Sands Missile Range. There it will undergo extensive tests to determine its effectiveness and the feasibility of its incorporation into the *Zeus* system.

Presumably the advanced radar would replace the huge transmitting and receiving antennas of the current *Zeus* Acquisition Radar.

• **Development background**— ZMAR has been under development by the Eastern operation of Sylvania Electronic Systems since 1959. Specifically, the technology and techniques of the phased-array antenna were developed as a result of an ARPA-sponsored program called CODIPHASE (Coherent Digital Phased Array System).



AN ADVANCED radar for Nike-Zeus will be capable of performing multiple functions such as those illustrated below.



BEAM-FORMING lines for the Sylvania Electronics Corp. phased-array radar are shown being checked under laboratory conditions. Production facilities are extensive and costly.

Although it is part of Project *Defender* for research into ballistic missile defense, all the work was under the technical direction of the Army Rocket & Guided Missile Agency—since incorporated into the Army Ordnance Missile Command at Redstone Arsenal, Ala.

• **Characteristics** — Although, like the reflector antenna, the phased-array radar determines target range and azimuth by measuring the time delay between the transmitted and received pulses and the antenna beam angle, it differs in that the antenna beam is formed in space and steered electronically.

In conventional radars, the RF energy from a single antenna feed is focused into a beam by a reflector dish or microwave lens, and the beam position is steered in azimuth and elevation by mechanical movements of the antenna.

This ability to electronically scan a radar beam, consequently, provides scanning patterns and scanning rates much higher than those that can be obtained with mechanical devices.

Another advantage of arrays is that due to the micro-second steering capability a single antenna beam can effectively time-share several targets. A phased-array antenna can also form multiple receiver beams and simultaneously steer each beam separately. Thus, the radar can perform concurrent search and tracking functions.

Since the array is made up of multiple antenna elements, extremely high-power RF tubes are not required. Rather, the transmitter power is obtained by summing the power outputs of all the elements operating in parallel. Low- or medium-power tubes, therefore, can generate greater RF power than comparable reflector-type transmitters.

One of the chief advantages of the array antenna, however, is that it can be shaped to fit the needs of the user. In other words, the "electronic" shape need not conform to the antenna's mechanical shape. This is particularly important in providing rigidity and "hardness" to the system to protect it against the blast—and to some extent the thermal—effects of a nuclear blast.

• **Picking a target**—In a simple array, the antenna elements are spaced in a uniform line along the ground plane. The radiated power from these elements, therefore, is along the boresight direction—perpendicular to the ground plane. By introducing a constant phase difference between adjacent elements, the direction of the beam can be changed. The additive energy from the antenna elements is steered to any position within approximately plus or minus 45 degrees from boresight.

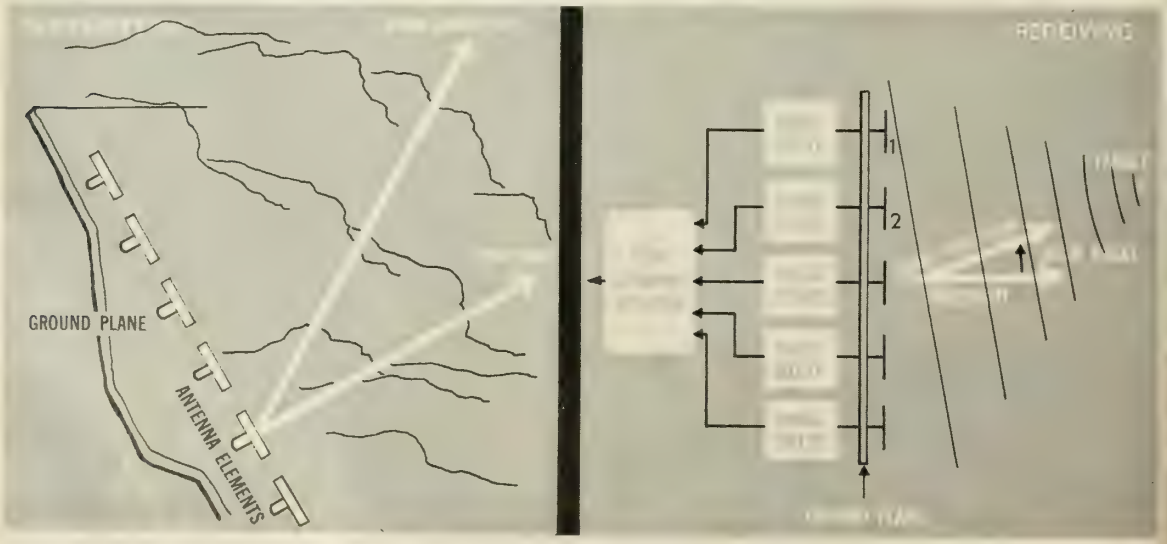
The reflected wavefront from a target off boresight will, therefore, arrive at antenna element 1 (see below) first, at the second element a little later, and so on.

The received signals are out of phase with one another. However, by introducing proper progressive phase delays into each element's signal channel, the reflected signals can be brought into phase with and added together in the beam-summing network.

Detection is improved in array antennas because of their superior antenna aperture control which in turn provides better sidelobe performance. Unwanted jamming or false signals are picked up by reflector antennas at approximately 25db below mainbeam signals while, in the array receiver, the sidelobe levels can consistently be maintained at 35db below the mainlobe.

• **Drawbacks**—The principal disadvantage of the phased-array antenna in

(Continued on page 42)



BEAM STEERING is accomplished by introducing phased delays into adjacent antenna elements located linearly along the ground plane (left). The received signal is delayed until all the elements have picked it up, and then is added in the summing network. The system will be given extensive tests at White Sands Missile Range, N.M.

NASA Budget

(Continued from page 17)

phased out this year, and is earmarked for only $13.2 million in the budget.

Launch-vehicle costs for the manned flight program during Fiscal 1963 are estimated at $747.9 million. The budget confirms that NASA is placing most of its chips on orbital rendezvous for the first lunar-landing flight. The advanced *Saturn* launch vehicle development program—which would be used in rendezvous—has been ticketed for $335.1 million. The *Nova* liquid vehicle which will be used for direct manned flights to the moon is down for $163.5 million. Estimated cost of the *Saturn C-1* vehicle which will send *Apollo* on earth-orbit missions is set in the budget at $249 million.

• **Space applications** — Budget requests in this area total $136.5 million—$51.1 million for meteorological satellites and $85.3 million for the various communication satellite programs which are under way. In addition, development of advanced satellites will begin.

The U.S. Weather Bureau has requested a budget of $45 million for meteorological satellites, $28 million of which is slated for reimbursement to NASA for satellites and launch vehicles.

• **Unmanned space exploration**— Total budgeted for these programs—including the *Orbiting Astronomical Observatory (OAO), Orbiting Geophysical Observatory (OGO), Ranger, Mariner, Voyager* and *Prospector*—is $543.7 million. Spacecraft development is slated to get $467.8 million.

• **Space technology** — This is the area in which almost all of NASA's in-house R&D effort is concentrated. Total budget is set at $452 million—$107.2 million for spacecraft and launch-vehicle research and $344.8 million for propulsion and space power.

Biggest item in the latter is liquid-propulsion development, budgeted for $163.1 million. This includes $55 million for the F-1 engine, $39 million for the J-2 and $55 million for the new M-1 engine. With another $26 million for this engine in the supplemental '62 budget request, some $81 million is tagged for its early development.

NASA's solid propulsion development for *Nova* will get $7 million.

Requested funds for the development of the new plasma-jet electric engine and other electrical power devices totals $30.6 million. Space power technology development, which includes Project *Sunflower*, is estimated to cost $20.1 million.

• **Nuclear systems technology**—A total budget of $315.7 million—a tremendous jump over last year—has been requested for research, development and operations in the nuclear space systems programs.

NASA is asking a total of $122.9 million. This includes $36 million for the *Nerva* nuclear rocket engine, $26 million for the *RIFT* (Reactor in Flight Test) stage which will house the engine during its test flights, $7 million for SNAP, $7.5 million for a flight vehicle for SNAP, and $12.5 million for hydrogen for the nuclear program.

The AEC is asking a budget of $192 million—including $10 million for plant acquisition, $90 million for the Project *Rover* nuclear rocket vehicle, $81 million for SNAP development.

Other major budget items in NASA's R&D and Operations programs are $52.5 million for aircraft and missile technology and $158.4 million for tracking and data acquisition.

A breakdown of the $818.9 million in new construction funds which NASA is requesting also shows the predominance of spending for the manned lunar landing program.

Some $635 million will be spent to build new facilities for the manned space flight program.

Launch complexes for the advanced *Saturn* and *Nova* vehicles will use up $359.9 million. Construction of a large flight acceleration facility will account for most of the $31 million in funds slated to go to the new Manned Spacecraft Center in Houston. The building will contain a centrifuge which will be able to swing a whole *Apollo*.

NASA's Langley Research Center will get some $8 million, largely for a Lunar Landing Simulation Facility. ⁂

Tires for the Moon

RUBBERIZED-fabric doughnuts are proposed by Goodyear for lunar vehicle wheels in this model. Full size: 16 ft. dia.; 125 lbs.

Missile/Space Budget

(Continued from page 13)

the *Titan III* space booster to be designed specifically for military missions.

For the first time, the new budget in a special section listed the space programs of all Federal agencies as a national program. Besides DOD and NASA, space appropriation requests were listed, in decreasing amounts, for the Atomic Energy Commission, the Weather Bureau and the National Science Foundation.

This packaging of separate programs in one national program is very much in line with the policy of Vice President Lyndon Johnson, chairman of the National Space Council, and Dr. Edward Welsh, the council's executive secretary. It is particularly indicative of the continuing Administration policy of seeking advances in military space technology through NASA's greatly expanding programs.

• **Two-year factor of three**—As a whole, appropriation requests for U.S. space programs have more than tripled in two years. In FY '61, Congress appropriated $1.7 billion for all space programs. The final figure for FY '62, including a proposed supplemental for NASA of $156 million, is expected to total $3.1 billion—still well below the new total for FY '63 of $5.5 billion.

The bulk of this money has been sought since Russia successfully launched the first manned *Vostok* into orbit last April. The details of the NASA budget strongly reflected this influence.

Conservatively, some 60 to 70% of NASA's new money requests—about $2.2 billion to $2.6 billion—are being sought for projects related in one way or another to the *Apollo* program.

One noteworthy sidelight in the new budgets of both the Defense Department and NASA was the introduction of several new elements of obfuscation along with a revolutionary new system of budget-making in the Pentagon.

NASA's budget-making adjustment lumps together for the first time funds sought for R&D and salaries and expenses—thereby obscuring considerably the cost of in-house operations.

The Defense Department completely reorganized its budget on the basis of "end product". In doing so, the military services' budgets were submerged to the point of eliminating total requests and many details for each service in the official documents.

Officials denied that greater unification by budget was under way, or that information was withheld intentionally. As one spokesman put it:

"It didn't fit the format." ⁂

'The Twins'—

STEPS BEYOND MARS

THIS IS THE THIRD in a series of articles discussing the possibilities for probes and manned travel to the other planets of our solar system. Earlier articles covered Jupiter (M/R, Dec. 4) and Saturn (M/R, Jan. 8).

The author, Robert L. Forward, is a Hughes Research Laboratories physicist pursuing advanced studies at the University of Maryland. He has published numerous papers.

The next article in the series will examine the problems involved in exploring Pluto.

by Robert L. Forward

←

BATHYSCAPHE proposed by the author for use in exploring Uranus is shown in artist's conception moving through the planet's ammonia-filled atmosphere. The float would contain pure hydrogen and be 10-30 times bigger than the pressurized living quarters attached beneath it.

Most Hospitable of Outer Planets?

EXPLORATION of the "twins"—Uranus and Neptune—poses special problems for future space travelers.

But by the time man is ready to make this journey to the outskirts of the solar system, perhaps late in this century, techniques for making reliable low-weight/high-powered energy sources probably will have reached the textbook stage. Transit times will be reduced—even over billions of miles.

• **The Planetary Twins** — The two pale green planets beyond Saturn are practically twins. Although they are much smaller than Jupiter and Saturn, they are still in the class of gaseous giants. Both have a diameter about 3.5 times that of earth.

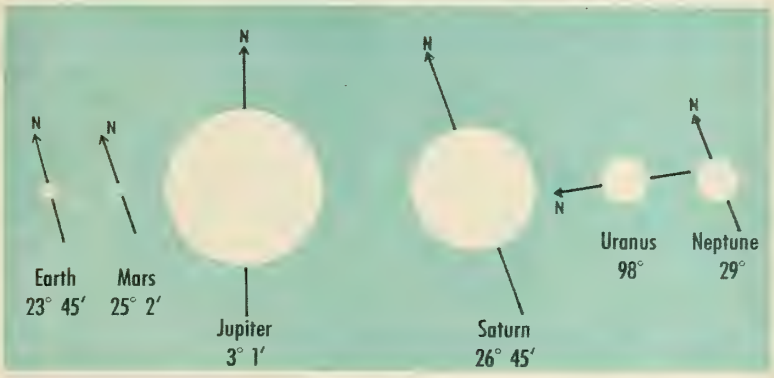
The major difference is their mass. Neptune has 17 times the earth's mass; Uranus, with a slightly larger diameter, is only 14 times heavier than earth.

Their composition and structure is probably very similar to Jupiter's. They have hydrogen-helium-methane-ammonia atmospheres, but the ammonia is mostly frozen out of the upper strata due to the lower solar heating at their great distances. Since the clouds and belts so prominent on Jupiter are made of ammonia crystals, there is little to see in the way of features on Uranus and Neptune. The only permanent feature reported is a faint white equatorial belt on the pale green globe of Uranus.

Both Uranus and Neptune rotate very rapidly and hence have substantial polar flattening. Using the known data, Wildt developed models for the two planets; since they are almost identical, only one is reproduced here (see p. 36). There is a central rocky core with a radius of about 7000 miles, a 6000-mile ice layer and an atmosphere between 2000 and 3000 miles deep.

• **Triton**—Like Titan, sixth moon of Saturn, Triton, the inner moon of Neptune, would be a more than adequate substitute for the planet Mercury. No atmosphere has yet been detected on Triton, but its surface gravity is even higher than that of Titan. Thus we are almost positive that it does have a substantial methane atmosphere.

Triton is closer to Neptune than Titan is to Saturn, but Neptune has a smaller mass. Because of this, Triton will be just as easy to get on and off of as Titan—if refueling from these planet-moons proves to be practical.



MAJOR PUZZLE to be answered with regard to "twins" is why, while Neptune's equatorial inclination is similar to other planets', Uranus's is about 98°.

• **Life on the Outer Planets** — We are fairly positive that some sort of extraterrestrial life exists. The conditions on Mars, especially — although quite rugged by earthly standards—are not sufficiently different from those on earth to rule out the existence of some low form of carbohydrate life similar to terrestrial lichens.

There is very strong evidence for such vegetation on Mars; for instance, the dark areas or "seas" can regenerate their color after being buried by sandstorms, and the infrared light from these same "seas" has a band structure usually associated with organic molecules.

Life on the outer gaseous planets, however, is not so easy to postulate. We know very little about the temperature, pressure or composition of the inner layers of their atmospheres. We can only say that if life does exist on Jupiter, Saturn, Uranus or Neptune, it is substantially different from the life forms we are used to.

However, the fact that conditions are widely different from those on earth is not a valid reason for saying that life cannot exist. For instance, it may turn out that the outer planets do not have a solid surface under the atmosphere—that the atmosphere merely gets denser as the pressure increases with depth. But high pressures and the lack of a solid surface are no barrier to the proliferation of deep sea fish here on earth.

Lack of oxygen, and the existence of poisonous gases such as methane and ammonia, are likewise no barrier. In fact it is believed that the atmosphere of the earth was high in these compounds before vegetation changed it to its present oxygen-nitrogen combination.

• **Formation of life from elemental compounds** — Since methane and ammonia contain the important elements for carbon-based life, they are to be considered not as poisons, but as the basic building blocks of life.

Dr. Carl Sagan, of the University of California Space Science Laboratories, recently duplicated the atmosphere of Jupiter in the laboratory and then bombarded it with ultraviolet rays. Simple organic compounds, the precursors of life, were formed. From the production rate, Sagan estimated that on Jupiter these molecules form at the rate of 10 lbs. per square mile per year.

Sagan did not have the laboratory area or the patience of a planet. He did not wait for that inevitable accident —when those organic compounds will fortuitously arrange themselves into the first piece of prelife capable of reproducing itself. But the outer planets can wait, and somewhere in those billions of tons of organic matter, that lucky accident has, is or will happen.

The prelife will form and, since such simple molecules can reproduce themselves in microseconds, it will not be

long before they take over the lower atmosphere. When there are enough of them so that there is competition for food, then natural selection—"survival of the fittest"—takes over, and the climb to more complex organisms is inevitable.

• **Temperature**—The most important factor in a planet is its temperature structure. If the temperature is low, solid surfaces can exist that would not be possible at higher temperatures. However, higher temperatures are more conducive to the formation of life, since the activity of organic molecules increases with temperature.

Unfortunately, we can see only the upper layers of the outer planets. Calculations of heat radiation into space and heat intake from the sun require measurements not easily made from our own absorbing atmosphere. The sources of internal heat, such as radioactive materials and chemical processes, which assume a major importance in a planet with a shielding atmosphere, are impossible to calculate with the meager knowledge that we have.

The measured temperature for the planets are given in the table below. Because we can see only the upper layers of the atmosphere, the temperatures are quite low. But this is not indicative of the temperature of the inner layers.

The second column of the table gives the equilibrium temperature of a completely absorbing sphere at the same distance from the sun. This is the highest temperature a planet can obtain as a result of solar radiation. We see that the four gaseous planets are hotter than they are supposed to be. This is a positive indication of internal heating and leads one to expect quite reasonable temperatures in the interior.

• **Across the Solar System**—Many people have stated that we will never go to the distant planets such as Uranus, Neptune and Pluto because the round trip would take a man's lifetime.

Their error was in assuming that the journey would be taken at a velocity corresponding to the escape velocity from earth. They did not reckon with the ion rocket or other methods of obtaining long-duration thrust. We now know approximately what power sources are needed to make the journeys in a reasonable length of time. Some typical figures from the literature for a journey from earth to Neptune (or Pluto after 1969) are:

WILDT'S MODEL indicates composition of both Uranus and Neptune.

Earth to Neptune

Initial Total Mass (Tons)	1500	3000
Payload Mass (Tons)	50	350
Powerplant Mass (Tons)	250	250
Specific Power (kw/kg) (mw/ton)	1	4
Power Output (mw)	250	1000
Transit Time (days)	680	540

These powerplants are a little beyond us now, both in total power and in specific power, but they must be developed if we are going to go any farther than Mars.

Because of the difficulty of lowering the transit time, the three outer planets should be visited by a single expedition. Toward the end of the century the three planets will fortunately all lie in the same direction from the sun.

• **Manned exploration of Uranus and Neptune**—Despite its distance, Uranus may be the first of the outer planets to be explored by man. This is because the escape velocity is only 22 km/sec., compared to 37 km/sec. for Saturn and 61 km/sec. for Jupiter. The surface gravity is less than 1 g at the top of the atmosphere and only 1.5 g at the ice layer of the Wildt model. Thus, gravity will not prevent exploration of the solid surface of Uranus (if it has a solid surface).

The major problem for designers of vehicles to be used on the surface of Uranus is the high pressure, which will be in the hundreds of atmospheres. But the problem of scientific investigation of hostile environments at high pressures has already been solved here on earth by Jacques Piccard.

In his bathyscaphe, Piccard has descended seven miles into the Challenger Depth, where he observed fish living at a pressure of 16,000 lbs./sq. in.—over 1000 atmospheres. This is much greater than the pressures expected on Uranus.

Since the pressure of the hydrogen-helium-methane atmosphere will be quite high, the density of the atmosphere will also be high. It is possible that a vehicle similar to the bathyscaphe could be used for exploration of Uranus.

The float would contain pure hydrogen (no danger of explosion here) and its linear dimensions would need to be only 10-30 times larger than the pressurized living quarters in order to lift it.

The motive power would come from the reaction of an oxidyzer, carried in the "fuel" tanks, with the hydrocarbons in the atmosphere. If propellers were used, they would have to be designed to operate in an atmosphere with a density midway between air and water. In fact, with the weak sunlight filtering down through the green atmosphere, an undersea explorer would feel quite at home on Uranus.

The real problem of manned exploration of Uranus is not in the conditions on the planet, but in the method of getting the men and equipment onto the planet and off again when the home base is billions of miles away.

If the outer planets do not have a

(Continued on page 45)

The Tale of the Temperatures

	Lowest Visible Surface	Measured Temperature	Solar Heating Equilibrium Temperature (°K)
MERCURY	solid	613	633
VENUS	cloud	370	330
EARTH	solid	295	280
MARS	solid	260	230
JUPITER	cloud	143	122
SATURN	cloud	120	90
URANUS	cloud	115 (?)	64
NEPTUNE	cloud	108	51
PLUTO	(?)	(?)	44

Uranus, Neptune and Triton Statistics

	URANUS	NEPTUNE	TRITON
Orbital Radius (km)	2.87×10^9	4.50×10^9	3.5×10^5
Period (days)	30,687	60,184	5.88
Rotation (days)	.45	.65	5.88
Radius (km)	23,800	22,300	2,000
Mass (kg)	8.7×10^{25}	10×10^{25}	1.5×10^{23}
Density (gm/cm^3)	1.56	2.27	4.5
Surface Gravity (cm/sec^2)	940	1500	250
Escape Velocity (km/sec)	22	25	3 + 6
Orbital Velocity (km/sec)	16	18	2

Boeing To Seek Review Of Excess Profits Ruling

THE BOEING CO. will ask for a review of a ruling that it had excess profits of $13 million in renegotiable government business during 1952.

The request for a review before the full 16-judge U.S. Tax Court follows a ruling two weeks ago by Judge Graydon G. Withey, ending the company's excess-profits case dating back to Dec. 5, 1955.

Boeing President William M. Allen said: "Not withstanding Judge Withey's ruling, Boeing's renegotiable profits in 1952 and later years were reasonable and not excessive. Judge Withey's ruling was inconsistent with objectives of Congress in enacting renegotiation and demonstrated a complete misunderstanding of the basic issues upon which the decision of the case depended . . ."

In the 1955 decision, the Renegotiation Board issued a unilateral order determining that Boeing in 1952 realized excessive profits of $9.9 million on renegotiable business with the Air Force. After additional evidence was presented to the Tax Court by both Boeing and the Board, the latter upped its claim of excessive profits to $20 million. The Tax Court then set the excess profit figure of $13 million.

In reaching the decision, the Tax Court ruled that: (1) expenditures by Boeing for certain advertising and other overhead expense is not allocable to its renegotiable business in 1952; and (2) cost of work performed with respect to the design, development and construction of the 707 prototype not in pursuance of any contract with the government is not allocable to renegotiable business in 1952.

The court said that even in light of the company's overall efficiency in performance of government contracts the "use of largely government-furnished facilities and the use of those rates in incentive contracts under which by far its greatest profits were collected constitutes unconscionable exploitation of the United States in its procurement of military necessities."

JPL Reorganizes Its Contracting, Procurement

CALTECH'S Jet Propulsion Laboratory has reorganized its procurement and Contracts division into four new sections—a move expected to increase the number of firms with which the lab does business.

One result of the reorganization will be an ambitious undertaking—a plan to provide JPL eventually with a "capabilities file" listing every firm in the U.S., large and small, that could possibly assist in the lab's program.

This will be the job of the new Industrial Evaluation and Assistance section, charged with tracking down, surveying and rating potential contractors according to capabilities, performance, quality control, management, financial condition, facilities and personnel. The new section, headed by Gordon R. Lawrence, also will assist firms in making presentations to JPL.

Other new sections and their managers are: Fabrication Facilities Procurement, David G. Malcomson; Supply Procurement, Ronald R. Nickbarg; Research and Development Procurement, Donn W. Anawalt.

Largest of the sections is R&D Procurement, which will deal with procurement of goods and services to support the industrial needs of the lab's eight technical divisions. The section will be comprised of four groups, Space Sciences, Telecommunications, Guidance and Control, and a group to service the needs of the Systems, Engineering Mechanics, Physical Sciences, Engineering Facilities, and Propulsion divisions.

The reorganization makes it possible for each new section to fill lab needs by issuing either a purchase order or a contract. Formerly, there were two sections—one handling purchase orders, the other contracts.

MOTOROLA INC. has formed a Solid State Systems Division at Phoenix. Under Dr. H. William Welch, Jr., the division will apply integrated solid-state technology to development of electronic materials, devices and equipment for use in communications, microwave and industrial control systems. It will be divided into three departments: Controls, Electronics and Research.

ITEK CORP's Vidya, Inc. and Palo Alto Itek divisions have begun a major expansion of administration and laboratory facilities in Palo Alto, Calif. Ground was broken last week for three buildings: a 15,000-sq.-ft. research unit, a 12,000-sq.-ft. administrative building and a 27,000-sq.-ft. shop and lab. Occupancy is scheduled for mid-year.

Vidya specializes in research related to Aerospace problems in such areas as hypersonic flight and high-temperature physics.

Itek is also building a 58,000-sq.-ft. building in Burlington, Mass., for its Electro-Products Division.

BOEING'S Aero-Space Division is forming two new branches as part of a management reorganization. Both branches will be given functional and staff organizations to provide a high degree of self-sufficiency.

The division's *Saturn* program, under George Stoner, will become the nucleus of a new *Saturn* Booster Branch. Separate functional organizations such as engineering, manufacturing, and materiel will be formed almost immediately.

A Space Systems Branch is to encompass the division's *Dyna-Soar* effort and other present or projected space vehicle programs of an "orbital and beyond" nature. It will be headed by George Snyder, former division director of engineering.

Financial Reports

COMPANY	PERIOD	INCOME		EARNINGS	
		1961	1960	1961	1960
Associated Testing Labs.	6 Mo. Nov. 30	$ 1,229,487	$ 831,560	$ 97,710	$ 88,048
Elgin Nat. Watch Co.	40 Wks. Dec. 3	31,402,588	26,526,009	1,245,006	717,023
Electro Instruments, Inc.	6 Mo. Nov. 30	4,796,731	3,957,657	199,484	—222,665
Electronic Communications, Inc.	Year, Sept. 30	22,280,994	23,957,815	306,153	—557,707
Hewlett-Packard Co.	Year, Oct. 31	85,590,239	76,809,369	5,873,872	4,991,739
IBM	Year, Dec. 31	1,694,295,547	1,436,053,085	207,227,597	168,180,880
Infrared Ind., Inc.	6 Mo. Oct. 31	2,760,200	806,060	62,774	56,276
Int. Electronic Research Corp.	Year, Sept. 30	6,289,729	5,239,834	452,571	346,507
Radiation Inc.	16 Wks. Dec. 15	7,344,600	8,954,100	132,600	245,000
Ryan Aeronautical Co.	Year, Oct. 31	89,448,172	122,711,095	3,304,645	2,894,055

COMMUNICATION

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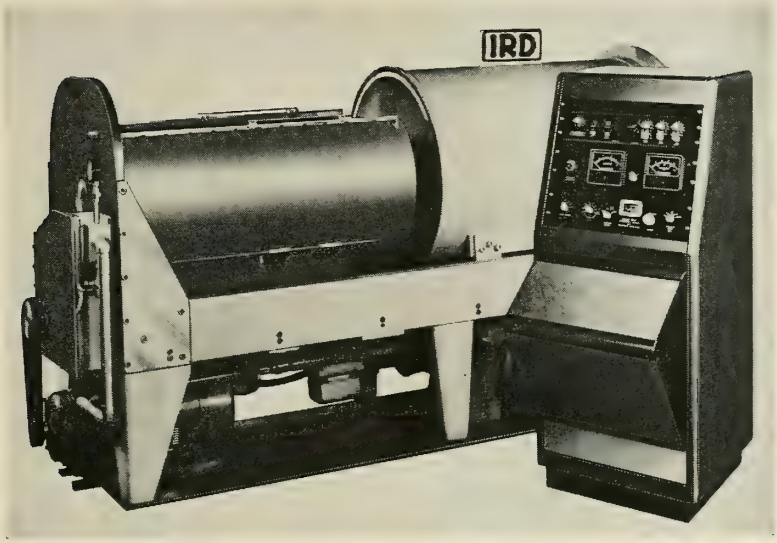


New Product of the Week: Vacuum Chamber Balance Stand

A vacuum-chamber balancing stand that detects and measures vibrations in electronic and space-age components has been developed by the International Research and Development Corp.

The vacuum chamber avoids air turbulence that previously handicapped fine balancing where high speeds are involved and duplicates the environmental conditions of outer space.

In one typical application, a high-speed induction pump was balanced to 0.008 oz-ins. at 20,000 rpm. The field-tested model will accommodate work-pieces ranging from 2 to 100 lbs., between 3 and 30 in. in length, diameters up to 11 in. and rotating speeds from 600 to 75,000 rpm. Slight modifications would enlarge these ranges.

Special models can be designed to cover a wide range of rotors of many configurations, sizes and weights.

Circle No. 225 on Subscriber Service Card

PistoLaser

Kollsman Instrument Corp. has introduced four models of a commercially available portable optical laser. Called PistoLaser, because of a double pistol-grip operator handle, the device emits high-intensity coherent narrow-beam light pulses potentially useful for space communications research, medical studies, and other applications.

Circle No. 226 on Subscriber Service Card

Servo Motor Generator

A size 11 servo motor generator in a one-piece housing providing a compact, rugged construction for consistent performance under extreme operating conditions is available from the Instrument Division of Thomas A. Edison Industries, McGraw-Edison.

Available with or without gear heads, the motor generators are designed to meet and exceed the requirements of MIL-S-17806, MIL-S-17807 and MIL-E-5272B. Operation of the motor may be on either 400 cps or 60 cps and a number of control phase voltages are available.

Circle No. 227 on Subscriber Service Card

Two Color Storage Tube

A two-color direct-viewing display storage tube is available from Hughes Aircraft Company's Vacuum Tube Products Division. The tube is capable of displaying and retaining information in either of two colors, or in several distinctive hues resulting from a mixture of the two basic colors. Construction of the new tube is similar to Hughes Tonotron storage tubes.

Application of the new tube is said to be practical in virtually any system requiring clear display of processed data. Air traffic control and sonar displays are typical examples. By substituting several distinctive colors for a continuous monochromatic range as in conventional half-tone tubes, users may achieve color-coding of information. Using color, variables in a display may be readily distinguished qualitatively and even semi-quantitatively.

Circle No. 228 on Subscriber Service Card

Magnetic Recorder/Reproducer

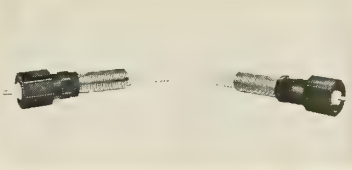
A magnetic recorder/reproducer with extremely precise time-displacement accuracy is available from the Westrex Recording Equipment Division of Litton Systems, Inc.

The RA-1681A has proven its capability of playing back 9.6 minutes of recordings at 14.4 inches per second with a time displacement of less than 2.4 microseconds. Over this 9.6-minute period, the time required to reproduce a standard weather chart with facsimile equipment, 691.2 feet of data are recorded with only a 20-mil difference in length between recording and playback, or about one mil in 35 feet.

Circle No. 229 on Subscriber Service Card

Coaxial Plug

Cannon Electric Co., is marketing a lightweight aluminum coaxial plug for use with RG-209/U cables, and embodies the highest level of performance



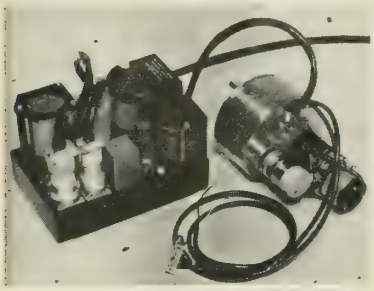
yet achieved in RF coaxial plugs. The plug is capable of continuous operation at 1000 watts CW over a range of 0.035-5.0 kilomegacycles at sea level or up to an altitude of 70,000 feet.

It remains sealed even while unmated, and the center contact is capable of withstanding an axial pull of 150 pounds. Also, the ALLT will resist 170 hours of salt spray; 10 cycles or 240 hours of humidity and elevated temperatures; 12 hours of sand and dust; and 6 cycles of thermocycling in a temperature range of −55°C to 95°C.

Circle No. 230 on Subscriber Service Card

D-C Integrating Servo

Kearfott Division, General Precision, Inc., is producing the CZ01714002 d-c integrating servo which provides an



accurate integration of d-c input voltage with respect to time as a function of shaft angle displacement. The integral-plus-proportional combination amplifier provides infinite gain, causing essentially no variation in output speed because of change in load, frequency, and line voltage. The command signal is isolated, and command signal loading is less than 30 microamperes.

Circle No. 231 on Subscriber Service Card

Hot-Molded Potentiometer

A complete line of ½-in.-diameter, ½-watt, hot-molded carbon variable resistors are now available from Centralab, The Electronics Division of Globe-Union, Inc. The unit meets all of the environmental and test requirements of MIL-R-94B (Style RV6).

The Model P unit has hot-molded resistor track molded into its insulating base. It is available in a wide range of resistances, from 100 ohms to 5 megohms, linear taper and 500 ohms to 2.5 megohms, log taper. Most values are stocked by Centralab Industrial Distributors for immediate delivery at prices ranging from $3.20 to $4.32 each, depending upon quantity.

Circle No. 232 on Subscriber Service Card

Adjustable Limit Stop

For reversing servo and syncro components at a foreordained position, a miniature electrical adjustable limit stop is being supplied by Sterling Instrument. The assembly also prevents damage to syncros incurred by excessive shock. Its characteristics include a cam assembly, a single-pole double-throw switch, and bearing hangers, complete with bearings and shaft. The cams are adjustable to actuate the switch at any angular switching limit, between 0.0° and 180° of shaft rotation.

Circle No. 233 on Subscriber Service Card

Hydraulic System Checkout

A portable testing instrument for quickly and accurately locating the source of trouble in a malfunctioning hydraulic system is being manufactured by the Owatonna Tool Co. The Flo-Rater is designed for testing hydraulic systems which deliver up to 30 gpm and 300 psi. It eliminates all guesswork in trouble-shooting hydraulic systems by measuring flow at various pressures in any part of the system, and indicates quickly and accurately whether or not a component is functioning properly.

Circle No. 234 on Subscriber Service Card

Integral Motor Clutch

A compact, unitized motor clutch assembly is available from Precision Specialties, Inc. A spring-type clutch and solenoid operated actuator assembly are mounted integral with the shaft and frame respectively.

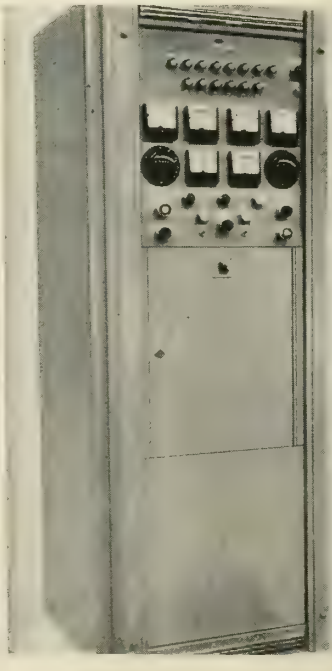
Start-stop, single revolution, or fractional revolutional clutches are available to provide a variety of control and indexing functions. A flexible coupling mounted on the clutch output hub allows some misalignment between the motor clutch assembly and driven member.

Circle No. 235 on Subscriber Service Card

Soft-Tube Modulators

Two standard soft-tube modulators with peak output powers up to 1.1 Megawatts are available from the Narda Microwave Corp.

The model 11020 provides peak pulse power outputs up to a maximum of −18 KV at 20 A, while the model 11040 provides a maximum of −33 KV at 33 A. Both models are furnished with three standard pulse widths of 0.5, 1.0 and 2.5 microseconds, and the pulse width desired is easily selected by means of a simple front panel switch. The pulse repetition rate is continuously variable from 200 to 2000 pulses per second.



Circle No. 236 on Subscriber Service Card

Variable Delay Lines

Andersen Laboratories, Inc., has available a series of step-variable-delay lines which feature high-delay to rise-time ratios, wide impedance range, good pulse fidelity, low attenuation and highly reliable operation. Up to 72 steps, with or without indexing, are available with a single adjustment shaft. Digital operation is possible using an eleven-position switch for each digit required. These delay lines are sealed in metal cases, with a suitable mounting and terminals provided.

Circle No. 237 on Subscriber Service Card

Intensity Scanner

A laboratory microphotometer for measuring intensity distribution in optical images, and other applications, is available from Intectron, Inc. The unit is essentially a low power traveling microscope designed to be used with photomultiplier photometers. The VS 12 was developed for scanning and measuring the intensity distribution in optical images. However, it can also be used wherever accurate photometric measurements of small objects—whether or not self-luminous—are required.

Circle No. 238 on Subscriber Service Card

new literature

PYRON BURNOFF SYSTEM—Avien, Inc., has published a brochure describing a Pyron Burnoff System, initially developed by the company for use on liquid-fueled ICBM missiles, but with applicability to other missile programs as well. The Pyron System is designed to dispose of large quantities of toxic propellants, such as aerozene 50 and nitrogen tetroxide, in either vapor or liquid form.

Circle No. 200 on Subscriber Service Card

INDUSTRIAL PROCESS INSTRUMENTS—A condensed catalog is available from Minneapolis-Honneywell. The G-la describes ElectroniK instruments, ElectriK and Pneumatic Tel-O-Set lines, Millivoltmeters, Primary Sensors, Filled-System Thermometers, Pressure Gauges and Transmitters, Flow and

Liquid-Level Meters, Duro-O-Pulse Telemetering Systems, Special Purpose Instruments, Computers and Data Handling Systems, Basic Industrial Controls, and Control Valves. Included are 48 pages of information on Honeywell instruments and systems for measuring, recording and controlling industrial processes.

Circle No. 201 on Subscriber Service Card

POWER TUBES—A booklet on vacuum power tubes, rectifier tubes, thyratrons, and ignitrons, featuring novel quick-selection charts for equipment designers, is available from RCA. The booklet also covers informative descriptions of tube design, including important thermal considerations and the Cermolox construction. The data section provides information on over 200 different transmitting, industrial, and special-purpose power tubes. Price $0.75.

Circle No. 202 on Subscriber Service Card

WIRE AND CABLE—Hitemp Wires Co., has published a catalog containing synopses of government wire specifications, government and commercial specifications, new product highlights, easy-reference tabulations on applicable military specifications, U.L. listings and ratings, physical dimensions, and dielectric strength and temperature ratings for the company's magnet wire.

Circle No. 203 on Subscriber Service Card

MICROWAVE CATALOG — A 32-page brochure of microwave instrumentation is available from Hewlett-Packard Co. The book deals only with the generation, transmission and measurement of microwave phenomena. Contents have been arranged by frequency range instead of model number.

Circle No. 204 on Subscriber Service Card

VARACTOR GENERATORS—A 12-page booklet, is available on request from the Waveguide Systems Division of Microwave Associates, the booklet discusses in detail both circuits and devices which use varactor diodes for frequency multiplication. It includes specific examples of recent accomplishments at the firm.

Circle No. 205 on Subscriber Service Card

INSTRUMENTATION — A brochure from C. L. Berger and Sons, Inc., covers the firm's capabilities in precisely-graduated dials and verniers with arcs and segments accurate to one second of arc, tapered spindles accurate to .00005-in., for rotating mechanisms, precision level-vial assemblies with sensitivities ranging from one second of arc per two mm. division, to 30 minutes and alignment and other optical-mechanical instrumentation devices of high precision.

Circle No. 206 on Subscriber Service Card

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Message Switching	**Other Related Projects**

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Circle No. 8 on Subscriber Service Card

contracts

AIR FORCE

$34,037,083—**North American Aviation Inc.**, Downey, Calif., for production of *Minuteman* guidance and control systems, and for modification of *Hound Dog* missiles (two supplemental contracts).

$33,464,000—**Thiokol Chemical Corp.**, New York City, for continued research and development of first-stage *Minuteman* engines through flight and qualification tests.

$31,372,847—**North American Aviation**, Los Angeles, for *GAM-77A* missiles, and for spare parts for *Minuteman* guidance and control systems (two contracts).

$9,709,077 — **North American Aviation**, Downey, Calif., for research and development of guidance and control of the *Minuteman* missile, and for overhaul and repair of *Hound Dog* missile components (two contracts).

$6,250,000—**Lockheed Aircraft Corp.**, Sunnyvale, Calif., for *Agena* space vehicles.

$5,753,055—**Avco Corp.**, Wilmington, Mass., for development of *Titan I* and *Atlas* ICBM missile re-entry vehicles.

$5,000,000—**General Electric Co., Flight Propulsion Division**, Cincinnati, supplemental agreement No. 1 to contract AF 33-657-7514.

$4,200,000—**General Dynamics Corp.**, Rochester, N.Y., for communications system engineering, development, management of installation and production of equipment for *Titan* missiles sites.

$4,111,971—**Avco Corp.**, Wilmington, Mass., for research and development for advanced ICBM weapon systems penetration aids, and production of *Titan* re-entry vehicles.

$3,300,000—**General Electric Co.**, Syracuse, for development and production of an early warning system for air-breathing missiles.

$3,015,000—**Hughes Aircraft Co.**, Culver City, Calif., for *GAR-11 Falcon* missiles, spare parts and related data.

$2,898,189 — **American Bosch Arma Corp.**, Garden City, L.I., N.Y., for fabrication of *Atlas* missile guidance sets and related items.

$2,500,000—**Page, River and Curran**, Rapid City, N.D., for installation and intersite control cable for *Minuteman* missiles.

$2,252,000—**The Boeing Co.**, Seattle, supplemental contract for assembly and checkout for the *Minuteman* ICBM, work to be at Malmstrom AFB, Mont.

$1,545,000—**Burroughs Corp.**, Radnor, Pa., for installation and support of electronics equipment for the *SAGE* program.

$1,515,000—**Boeing Co.**, Seattle, for assembly and checkout of *Minuteman* missiles.

$1,400,000 — **Radio Corporation of America**, Moorestown, N.J., for work on the Ballistic Missile Early Warning System.

$1,200,000 — **Aeronca Manufacturing Corp.**, Middletown, Ohio, for development of fabrication techniques and design procedures for insulated sheet beryllium-ceramic composite structure for re-entry and space vehicle constuction.

$1,000,000 — **Chrysler Corp.**, Detroit, supplemental contract for re-entry vehicle studies.

$944,550—**General Precision, Inc., Link Division**, Binghamton, N.Y., for flight simulators, spare parts, aerospace ground equipment, data, descriptive identification and maintainability requirements.

$549,158—**Avco-Everett Research Laboratory**, Everett, Mass., for studies of magnetohydrodynamic principles, and for investigations of ionized gases at elevated temperatures.

$371,067—**Electro-Optical Systems, Inc.**, Pasadena, Calif., for additional laboratory testing equipment in support of the ion engine program.

$224,222—**Applied Research Inc.**, Port Washington, N.Y., for production of a series of standard applied-research broadband radio-frequency amplifiers.

$152,697—**Lockheed Aircraft Corp.**, Burbank, Calif., supplemental contract for ejectable nose capsule program.

ARMY

$13,682,016 — **Bowen-McLaughlin-York, Inc.**, York, Pa., for recovery vehicle, full-tracked, with repair parts.

$885,000—**Elling Halvorson Co.**, Seattle, for construction of strategic missile support area facilities, Ellsworth AFB, S.D.

$598,503 — **Martin Construction Co.**, Cocoa Beach, Fla., for construction of G.M. support structures, Cape Canaveral Missile Test Annex, Air Force Missile Test Center, Patrick AFB, Fla.

$378,563 — **Western Electric Co., Inc.**, New York City for *Nike-Hercules* repair parts for fault-locating indicator.

INDUSTRY

$2,400,000—From **Martin Marietta** to **General Precision, Inc., Kearfott Division**, Little Falls, N.J., for a follow-on quantity of hydraulic systems for the *Pershing* missile.

$1,087,649—From **Aetron-Covina Plant**, a division of **Aerojet-General Corp.**, to **Systems Division** of **Beckman Instruments, Inc.**, for two data-acquisition systems for use in the *Saturn* space vehicle program.

$500,000—From **Martin Marietta Corp.** to **Ets-Hokin and Galvan, Inc.**, for installation of electrical, electromechanical and mechanical systems for the activation of *Titan II* training sites at Vandenberg AFB

NASA

$6,000,000—**Vitro Engineering Co.**, a division of **Vitro Corp. of America**, New York City, for a nuclear-rocket engine maintenance, assembly, and disassembly building (E-MAD) at the National Nuclear Rocket Center, Jackass Flats, Nev.

$656,191—**Westinghouse Electric Corp.**, Sunnyvale, Calif., for design, fabrication and field installation of a direct current power supply system for mass transfer cooling and aerodynamics facility, work to be done at Ames Research Center, Moffett Field.

$350,000—**Radiation at Stanford**, subsidiary of **Radiation, Inc.**, Palo Alto, Calif., for three high-power microwave transmitters for Project *Relay*.

NAVY

$26,500,000—**Bendix Corp.**, Mishawaka, Ind., for continued production of *Talos* missiles.

$10,997,027 — **Vitro Laboratory**, Division of **Vitro Corp.**, Silver Spring, Md., for research, analytical investigation, engineering and design work in connection with the Fleet Ballistic Missile System.

$4,769,433—**Hazeltine Corp., Hazeltine Electronics Division**, Little Neck, L.I., N.Y., for *AN/SSQ-28 sonobuoys*.

$4,000,000—**Lockheed Missile and Space Co.**, Sunnyvale, Calif., for tactical readiness and checkout equipment in connection with the *Polaris* program.

$1,480,517 — **Radiant Manufacturing Corp.**, Morton Grove, Ill., for rocket launcher Aero 6A-2.

$695,641—**J. L. Coe Construction Co., Inc.**, Charlotte, N.C., for anti-submarine warfare tactical trainer facility, Naval Station, Norfolk, Va.

Zeus' New Antenna

(Continued from page 32)

the past has been high cost. This is attributable to the fact that, instead of a single radiating element as in a reflector, an array calls for multiple radiators. This multiplicity also demands a number of feed systems, thus even further increasing the cost.

Finally, the complexity of the array electronic systems multiplies the cost. The steering and receiving electronics are complicated by the necessity of controlling the phase delay of the antenna elements, while the positioning of a reflector is a relatively simple electromechanical problem.

In addition, a parabolic antenna can be positioned to radiate an identical pattern over an entire hemisphere in space. In contrast, the sweep of a planar array is limited to a given angle from boresight. This problem, of course, can be eliminated with additional arrays—with a consequent increase in cost.

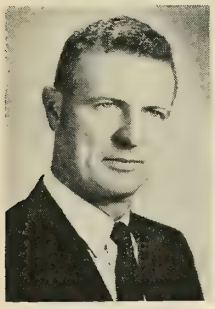
• **Zeus application** — The present *Nike-Zeus* system consists of four large radars: an Acquisition Radar, Discrimination Radar, Missile Track radar and Target Track Radar. These are tied into a Target Intercept Computer which collates that information from radars and computes the guidance and control parameters required for a successful intercept of the target.

Although the phased-array antenna could theoretically replace all of the electromechanical antennas, it is far more likely that its function will be restricted to acquiring the target. It is well suited for this type of mission because of its higher power capability and its ability to time-share a number of targets simultaneously. An additional advantage of the array in the *Zeus* system would be the combination of the receiving and transmitting stations into one system.

The higher RF power of the phased array would allow acquisition of the incoming warheads earlier in their trajectory, thereby increasing the discrimination time available and perhaps allowing earlier interception.

In discussing the new antenna, Sylvania officials refused to discuss the possible application of the system to *Zeus* because of security classification. It is clear nonetheless that the system will greatly improve the ranging accuracy of the system and provide greater flexibility in tracking—and preliminary detection—of multiple warheads.

The time-table for the installation of the reduced-scale antenna at WSMR is also classified. However, it is not expected that systems tests will be conducted on the new antenna until the middle of 1963. ⌗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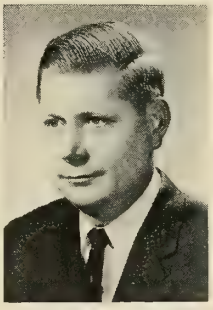
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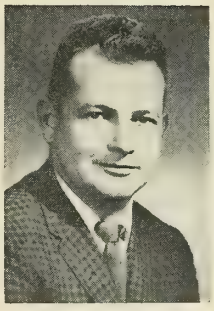
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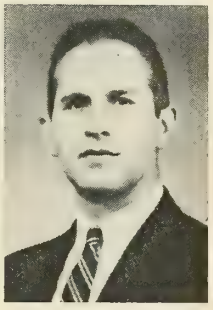
BRINSTER

Dr. Dana Young: Former dean of the Yale University School of Engineering, will join the staff of Southwest Research Institute as technical vice-president.

Douglas G. Harvey: Project engineer for the Martin Marietta Corp. of Baltimore, has been selected by the Institute of the Aerospace Sciences as the outstanding young man of 1961 in the aerospace field, and will receive the Lawrence B. Sperry Award on Jan. 23 at the Institute's 30th Annual Honors Night Dinner. Harvey is being given the award in recognition of his work in directing the design and construction of the first two nuclear generators to be used in space aboard the Navy's *Transit* satellites.

Also, **Robert R. Gilruth,** IAS Fellow and director of the NASA Manned Spacecraft Center, will receive the Louis W. Hill Space Transportation Award for his outstanding leadership in technical development of spacecraft for manned space flight at the same time.

Edgar S. Peierls: Chairman of the board of Resistoflex Corp. has announced the election of **Joseph M. Gentile** as president of the company.

John T. McGraw: Appointed vice president of the Vard division of Royal Industries, Inc. He joined Vard in 1960 as director of engineering and will continue in that responsibility.

James P. McMahon: President of Tullamore Electronics Corp., a subsidiary of The Victoreen Instrument Company, has been made a vice president of Victoreen.

Dugald Black: Named vice president for international operations by the board of directors of The Bendix Corp. He will have charge of the 12 Bendix foreign subsidiaries and affiliates.

Joseph T. Beardwood III: Announced as manager of the newly created Naval Warfare Department of General Atronics Corporation's Military Electronics Division.

Sidney Sparks and **Edwin W. Peterson:** Appointed executive vice president and a director and vice president and controller, respectively, of Radio Corporation of America Communications, Inc.

H. D. Carlson: Southwestern Engineering Company directors named him as president, succeeding **Robert P. Miller,** who has been elected to chairman of the board.

Edward T. Butler: Senior vice president of Electro Instruments, Inc., given the position of general manager of the San Diego firm. He will assume overall responsibility for the San Diego EI subsidiary.

Joseph W. Lewis and **Earl C. Janson:** Promoted to vice presidencies of Beckman Instruments, Inc. Lewis, manager of the Scientific and Process Instruments Division, will continue in that post in addition to serving as a company officer. Janson, vice president of manufacturing, will continue to coordinate the company's manufacturing programs, as he did in his former post of director of manufacturing. They will both serve as members of the Corporate Planning Committee.

Ralph J. Cordiner, Chairman of the Board of General Electric Co., has announced the election of **Hershner Cross,** general manager of the Radio and Television Division, **Dr. Charles E. Reed,** general manager of the Chemical and Metallurgical Division, and **Charles V. Schelke,** general manager of the International General Electric Company Division, to the posts of vice presidents of the company.

Dr. Franklin A. Gifford, Jr.: Meteorologist in charge at the U.S. Weather Bureau Research Station, Oak Ridge, Tenn., has been designated chairman of the Atomic Energy Commission's Advisory Committee on Reactor Safeguards. **Dr. Henry W. Newson,** professor of physics and director of the Nuclear Structure Laboratory, Duke University, Durham, N.C., will serve as vice-chairman.

P. R. Vogt: Appointed to the newly created position of assistant general manager and technical director of the Liquid Rocket division, and **W. J. Brennan** and **N. C. Reuel** to the positions of chief engineer and assistant chief engineer of Liquid Rocket Engineering, Rocketdyne Division of North American Aviation.

Richard L. Hopkins: Joined Accurate Specialties Co., Inc., last year as general manager, has been elected president at a recent meeting of the board of directors.

Dr. H. William Welch, Jr.: Will head up the new Solid State Systems Division of Motorola Inc. He has been directing the efforts of the Solid State Electronics and Solid State Controls departments since their inception.

Frank H. Erdman: Appointment to the presidency and election to the board of directors of General Devices, Inc. has been announced by **J. F. Brinster,** founder and recently named chairman of the board.

John W. McKane: Formerly sales manager, made vice president of Engineered Ceramics Manufacturing Company, Chicago. In addition to his new administrative duties, he will continue to direct sales and supervise application engineering of special refractory requirements.

Edgar Rice: One of the founders of Theta Instrument Corporation, named president and chief operations executive of the company.

Dr. Joseph P. LaSalle: Associate director of the Center for Differential Equations at RIAS, the Martin Marietta Corporation's Research Institute for Advanced Study, is new president-elect of the Society for Industrial and Applied Mathematics. He will assume the presidency in the fall. Elevated to the presidency was **Dr. Robert Rinehart,** professor of mathematics at the Case Institute of Technology. The outgoing president is **Dr. F. Joachim Weyl,** chief scientist of the Office of Naval Research.

H. A. Shepard: Board member and vice president-general manager of Thompson Ramo Wooldridge Inc., selected to replace **Dean E. Wooldridge,** president of the company since 1958, upon his resignation Feb. 1. Wooldridge will continue to serve as a board member of TRW and Space Technology Laboratories, Inc., a subsidiary of TRW.

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FEBRUARY

Western Electronic Week and Pacific Electronic Trade Show, Palm Springs and Los Angeles, Feb. 3-11.

American Society for Testing and Materials' Committee Week and Spring Meeting, Statler-Hilton and Sheraton-Dallas Hotels, Feb. 5-9.

Winter Convention on Military Electronics, IRE, Ambassador Hotel, Los Angeles, Feb. 7-9.

International Solid State Circuits Conference, Philadelphia, Feb. 14-16.

Golden Gate Metals Conference, Fairmont Hotel, San Francisco, Feb. 15-17.

American Institute of Mining, Metallurgical, and Petroleum Engineers, 91st annual meeting, Hotels Statler and Astor, New York City, Feb. 18-22.

Tracking and Command of Aerospace Vehicles, Institute of the Aerospace Sciences, San Francisco, Feb. 19-21.

Third Annual Symposium on Nondestructive Testing of Aircraft and Missile Components (Southwest Research Institute), Gunter Hotel, San Antonio, Tex., Feb. 27-Mar. 1.

MARCH

Institute of Radio Engineers, 8th Scintillation and Semiconductor Counter Symposium, Washington, D.C., Mar. 1-3.

Fifth Annual Technical Conference, Society of Vacuum Coaters, Sheraton-Cleveland Hotel, Cleveland, Mar. 6-7.

Armed Forces Communications and Electronics Association, Cape Canaveral Chapter, symposium, Cocoa Beach, Fla., Mar. 6-8.

Flight Propulsion Meeting (classified), Institute of the Aerospace Sciences, Cleveland, Mar. 8-9.

First Microminiaturization Congress and Exhibition, sponsored by American Watchmakers Institute, Hotel Commodore, New York City, Mar. 10-13.

1962 Symposium on Packaging of Chemical Products, sponsored by Manufacturing Chemists Association, Inc., St. Louis, Mar. 13-14.

Goddard National Space Conference, sponsored by the National Rocket Club, Sheraton Park Hotel, Washington, D.C., Mar. 14-16. (Goddard Memorial Dinner on Mar. 16.)

Electrical Propulsion Conference, ARC, Hotel Claremont, Berkeley, Calif., Mar. 14-16.

Third Symposium on Engineering Aspects of Magnetohydrodynamics, sponsored by University of Rochester, AIEE, IRE, IAS, University of Rochester, N.Y., Mar. 28-29.

APRIL

American Rocket Society, Launch Vehicles: Structures and Materials Conference, Ramada Inn, Phoenix, Ariz., April 3-5.

To Neptune and Uranus

(Continued from page 36)

solid surface, then there is another problem which almost looks unsurmountable. Where do you park the return rocket while you take a look around?

• **Origin of the Solar System**—To this date there is no established theory for the formation of the solar system. We have collected a great deal of data about the system, and any theory must explain these characteristics in a logical way.

The theory must account for the almost perfectly circular orbits of the planets around the sun and the moons around the planets. The orbits are usually in a common plane which coincides with the equator of the primary. The theory must give a logical development that will allow the sun to retain only 2% of the angular momentum of the original gas or dust cloud. Jupiter alone contains 60% of the angular momentum of the solar system and the four large planets contain 98%.

The real problem for any theory of the development of the solar system is to account for the discrepancies in the normal patterns: Why do Mercury and Venus have no satellites? Why was the asteroid belt formed between Mars and Jupiter rather than a planet? Why are the planets outside the asteroid belt so different from the planets inside the asteroid belt? Why don't the larger moons have satellites of their own? What is the explanation for the odd behavior and physical characteristics of Pluto?

One problem in particular that will be a real test for any theory is the explanation of the axial tilt of Uranus. As the following diagram shows, most of the planets have an equatorial inclination of about 25° to their orbit. Jupiter could be forgiven because of its large mass, but why does Uranus have its polar axis in the orbital plane? Why is this twin of Neptune so different in this respect?

One thing that will help a great deal in this problem of the origin of the solar system is to know the exact composition and structure of the planets. Our unmanned probes and manned explorations will give us these data.

Once we do have a firm theory for the formation of planetary systems from dust clouds, the astronomers will be able to determine what types of stars could have planets similar to ours. The recent attempts to detect radio signals generated by intelligent beings on planets around other stars could then be repeated—with a better chance of success. ⁂

The Significance of Zero

THERE ARE FEW surprises for the missile/space industry in the first complete Kennedy Administration budget. Generally speaking, it is a good budget from the viewpoint of the industry.

Detailed study, however, reveals two major and interrelated areas of concern which the Administration has slighted in its funding.

The three-year Department of Defense budget breakdown carries a line under procurement funding for "military astronautics." This line is blank for Fiscal 1961, 1962 and 1963. Three years wasted, 36 months of marking time, 1095 days irrecoverably down the drain.

Asked to explain why the item was carried at all, a DOD spokesman could only reply: "It has the significance of a zero entry." We think that significance is considerable. The FY '63 budget thus carries the message that the Kennedy Administration has done little better than its predecessor in activating a major military space program.

DOD is asking for total obligational authority of $1.5 billion for research, development, test, and evaluation in military astronautics during FY '63. This is up from $1.15 billion this year—not a major increase in view of what should be done in the field. The greater part of the spending is to be in such areas as reconnaissance and communications. There is little for manned military space flight. It is the outstanding deficiency in the budget.

It is understandable that DOD officials, while proud to point to an increase in the *Minuteman* force, are reluctant to discuss the *Dyna-Soar* program in relation to the budget.

Related to the lack of a major military space program is the failure to implement a big solid-booster program simultaneously with the big liquid program. Administration officials and the budget itself have made it clear that the solid *Nova* has lost its priority, as first reported in last week's MISSILES AND ROCKETS.

The budget report flatly states: "First attempts at manned lunar flight will be made with liquid-fuel rocket engines." It is the first official statement that the solids have been abandoned for this purpose.

The disappearance of a side-by-side solids development from the lunar landing program has taken an interesting course. As recently as Jan. 10, a top official of the National Aeronautics and Space Administration denied that there had been any change in implementing the President's decision, presented to a Joint Session of Congress, for developing both liquid and solid boosters for the initial lunar landing.

At his budget briefing, however, NASA Administrator James Webb made it clear that the space agency is putting all its chips on the liquids.

He said NASA did take up with the Bureau of the Budget the question of a major solids program in FY '63 to catch up with the liquid program. He estimated this might have added as much as a billion dollars to the NASA budget, an estimate which seems very high.

The decision not to include a solids program, Webb stated, was made for both fiscal and technical reasons. Among those taking part in the decision were NASA officials, the Budget Bureau and the Space Council. Then Administrator Webb made an interesting statement. With everyone agreed, he said, "It was not necessary to go to the President with an appeal."

We think this is a decision in which the President certainly must take a personal interest. Whether or not it is placed before him on appeal, it is a matter of utmost importance to the national security and welfare.

With the President's statement backing a dual liquid-solid approach before it, Congress last year appropriated the money for the lunar program. The President has not retracted that statement and no one from the Administration or NASA has taken the trouble to explain the change in direction to Congress. We suspect this arbitrary handling will result in some irritated questioning from the Hill.

THERE IS ONE hopeful development in the situation. Both the budget and Administration officials have made it plain that responsibility for the big solid program hereafter will rest with the Air Force, not NASA. The solids are to be brought along, although on a much slower time scale. If the Air Force can generate enough enthusiasm for solids, the program might yet be accelerated.

A NASA source says the Air Force FY '63 budget calls for spending of some $40 million on big solids, other than the 120-in. boosters for *Titan III*. It is not yet clear whether this is the expenditure planned during the year or is in addition to the $62 million set aside last year. In either event, while initiation of a big solids program is a step in the right direction, $40 million is hardly sufficient. That is far less than is being asked for the Peace Corps, a worthy but certainly less vital program.

We hope sufficient backing can be developed in Congress to overcome these two major deficiencies in the new budget. Undoubtedly, as more details on specific programs are released, other areas of concern may appear. But, with the exceptions noted, it appears to be a budget with strong support for the industry—and which the industry can strongly support.

William J. Coughlin

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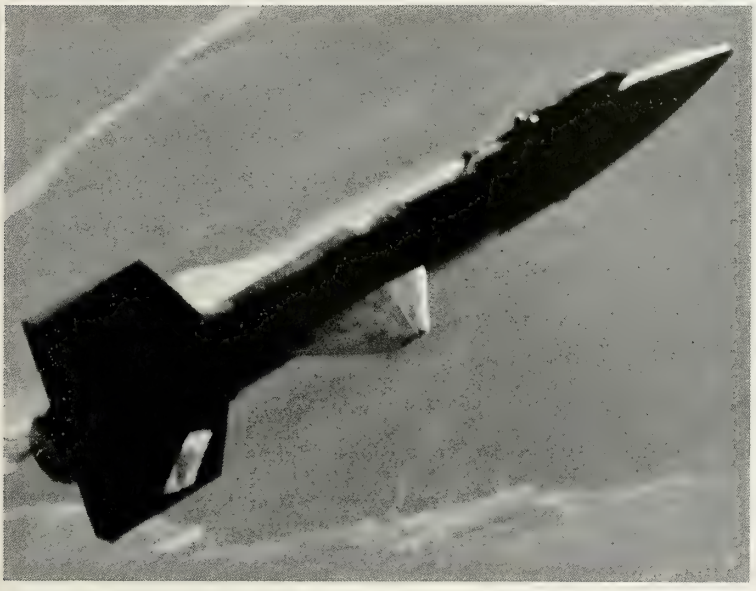

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missiles and rockets

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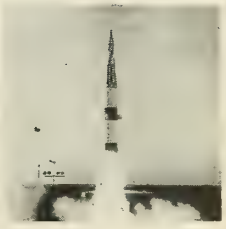

Army's Martin Pershing IRBM fired from Cape Jan. 16 flew 400 mi. and is near-operational version. Pershing is expected to reach combat status this year. See p. 15.

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†U.S. Reg. Pdg.

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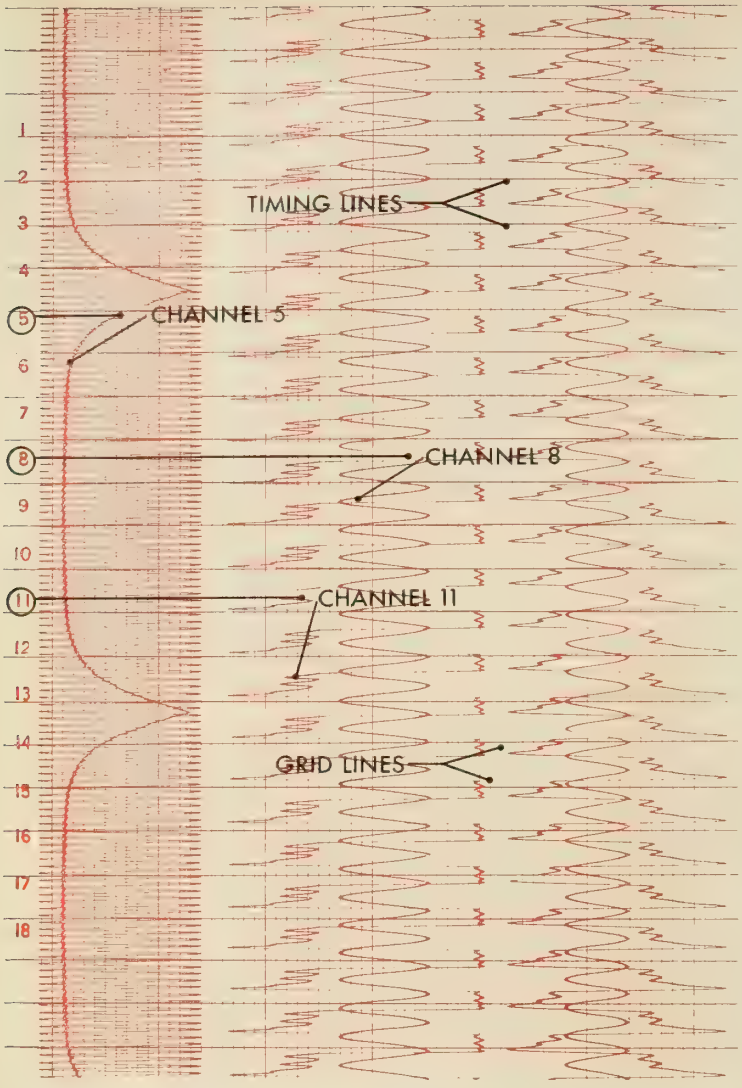

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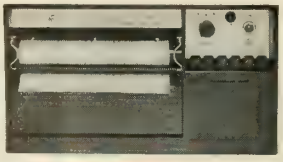

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letters

Double Patent Standard?

To the Editor:

I see in your Jan. 8 editorial ("Stifling the 'One Human Asset'") you again hammer away at that big nasty old government practically stealing the bread out of the mouths of those poor multimillion-dollar companies. You once again jump on the bandwagon along with many other trade publications. To boot, you even dress up your editorial with a quote from "Historian Toynbee," not to mention the completely unprejudiced report by a committee whose "directors and associate directors" are members of firms which stand to lose by the government's plans.

It is pointed out that "Inventive American industry, both large and small business, is convinced that the attitude of government is unreasonable. . . ."

Gentlemen, why do these same people not think it unreasonable that the engineers and staff, who work for them, must assign their patent rights to the company? Why this double standard? The argument is that the company pays salaries for the employees' time—hence it is entitled to their knowledge. I, for one, believe that if this is A-OK by industry, they should accept the fact that the government is paying them, and pretty well too. Ergo, company patents are the property of the employer—in this case, government.

As an engineer and a taxpayer, I think that ASPR IX, part 2, MIL-D-70327 and MCP-71-77 are no more "stifling" or "unfair and unworkable" than long-standing commercial practice.

Moses Tawil
Brooklyn, N.Y.

Trophy Philosophy

To the Editor:

A little weary of the lionized jockeys, the Lindberghs, the speedway drivers, air pilots, and such, *who merely ride the creations of the real and unsung heroes behind the scenes,* I nominate for the Goddard Trophy those men, or that foremost man, who, through long years of sweat and tears, trained or devised out of pure and inspired imagination the . . . machines which the jockeys ride to glory.

For once let us honor him or those who lead the technological parade into the future. . . .

It is as with the great music of the world: the hurrahs, the ovations and the "encores" usually go to the polished maestros—who can at best only follow the composer's directions—instead of the creators themselves. . . .

In space and missilery, such men as Goddard himself, Von Braun and his associates, and the others, best known to space researchers, who created these wondrous engines of exotic transportation—it is on *their* heads that we should place the laurel crowns of honor in everlasting gratitude.

Benjamin F. Miessner
Miessner Inventions, Inc.
Miami Shores, Fla.

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WHAT'S UP... AND WHERE ?

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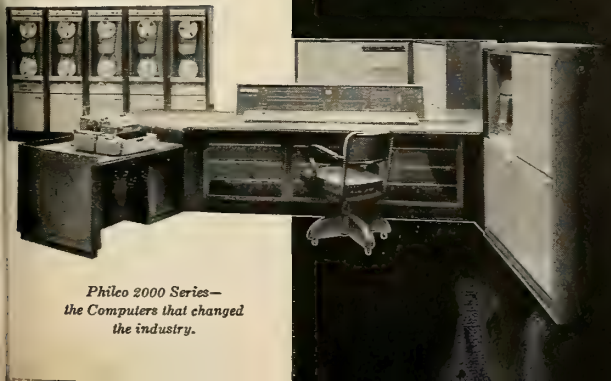

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Pratt & Whitney Aircraft has pioneered the use of this remarkable technique to cold-form steels, molybdenum, titanium, and tantalum into lightweight parts with diameters ranging from one-half inch to 80 inches, lengths up to 12 feet, and thicknesses controlled to within .002 inch. Even more advanced flow-turning methods involving hot metals are under development.

Such advances in metalworking typify Pratt & Whitney Aircraft's expanding capabilities in rocket technology.

Liquid hydrogen, for example, was considered too difficult to handle only a few years ago. A major Pratt & Whitney Aircraft effort made it a practical space fuel. The nation's first liquid-hydrogen engine, Pratt & Whitney Aircraft's RL-10, has passed its preliminary flight rating test and is in production for the Centaur and Saturn programs. In tests the RL-10 significantly exceeded performance guarantees and demonstrated unusual durability with individual runs up to 12 minutes during a series of continuous firings that totalled 63 minutes.

Today, Pratt & Whitney Aircraft scientists are investigating such diverse fields as emissivity in space vehicles, hydrogen-fluorine rockets, and advanced power concepts ranging from MHD and fuel cells to nuclear power. These programs, too, promise significant discoveries for rocket technology and national space capability.

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Reactor Controls
- *Rod Positioners*
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AiResearch experience in space nuclear power systems, and in hot gas and cryogenic control systems for aircraft and missiles, is directly applicable to the development of control systems for nuclear rocket and ramjet engines.

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An advanced AN/USD-2, proposed for development, would be a mobile multi-purpose system with expanded capabilities.

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The Countdown

WASHINGTON

Polaris Slippage To End

The Defense Department is planning to end the Administration-imposed day by day slippage in the construction of *Polaris* submarines beyond the 29th. The department says it will release funds to the Navy to order long lead-time items for the next six *Polaris* subs. However, plans now call for placing the sub-building program beyond the 29th boat on a basis of one every two months—rather than the projected one-a-month.

ICBM'S: Generation No. 3 Coming Up

The Administration decision to permit the Air Force to resume early work on a third generation ICBM is the latest indication that the United States will resume nuclear tests in the atmosphere—probably within a few months. One absolute requirement for the new ICBM is reducing the size and increasing the power of nuclear warheads. This is possible only by more testing.

FY '63 Budget Breakouts

Informed sources are saying the new budget requests include about $2 billion for *Minuteman* and about $42 million for *Dyna-Soar*. The *Minuteman* figure covers the entire program, including construction. About $650 million is expected to go to the principal contractor—Boeing.

Typhon Becomes a Star

The Westinghouse-Bendix *Typhon* system is rapidly becoming a leading item in the Navy's R&D effort. The aircraft/missile defense missile is considered essential for defense of the fleet in the later 1960's—especially against missiles launched from beyond the horizon.

Red Undersea Threat Grows

The Defense Department is increasingly concerned with the threat posed by Soviet missile-launching submarines. The Russians have been known for some time to have conventionally-powered subs capable of launching missiles. Current evidence increasingly indicates that the Soviets also have nuclear-powered missile subs. The missiles are considered to be short range. But even those could obliterate all of the big metropolitan areas on the East and West Coasts.

INDUSTRY

The Race for the 120-incher

Six companies are fighting for the R&D contract to develop the Air Force's 120-inch solid motor that will be clustered with *Titan II*. The six that have been invited to submit proposals: Aerojet, Lockheed Propulsion, UTC, Thiokol, Hercules and Atlantic Research.

Pershing and the NATO Market

As *Pershing* is readied for early production (see page 15), the outlook for European sales of the big tactical missile system are brightening. The West Germans are considered firmly committed to adding *Pershing* to their growing Army. As a result, France and several other NATO nations may follow suit. The West German buy alone is expected to top $100 million.

R&D Intelligence

Martin Marietta's Baltimore division is in line for a $2 million contract for R&D of a space program launch vehicle . . . Aerojet-General Nucleonics is investigating the use of fissio-chemistry via a $4 million AF contract to try and cut chemical production costs . . . In the same vein, General Dynamics/Electronics is researching for NASA the nucleation of crystals to see how solids are created from vapor under a hard space vacuum . . . First inclusive report on scientific problems in probing "The Atmosphere of Mars and Venus" ($5) is being issued by the National Academy of Sciences in Washington.

Army Starts TOW Studies

The Army—hunting for an *Entac* follow-on—has awarded three $500,000 feasibility studies for its proposed TOW wire-guided antitank missile. The studies will be conducted by Martin, McDonnell Aircraft and Hughes Aircraft.

Neat Trick

A quick-moving General Dynamics/Astronautics crew at the Cape removed an engine from the *Atlas-Agena B* holding the *Ranger* lunar hard landing spacecraft Jan. 22 while the booster was upright on its pad—and replaced it in 48 hrs. The maneuver—a first—was necessitated by a ruptured diaphragm which leaked fuel into the insulation above the engine.

INTERNATIONAL

What Did Ivan See?

One major question about the disputed Bulgarian air reconnaissance of a southern Italian missile base is the nature of the installation. The missiles have never been identified. However, they apparently are *Jupiter* IRBM's.

Third Space Power Sought

West European space programs have received a strong moral boost from the U.S. House of Representatives. Chairman George Miller of the House Space Committee says that a European "third force" to advance scientific technology in competition with Russian and the United States is essential for U.S. security.

Malenovsky vs. McNamara

Soviet Defense Minister Malenovsky has delivered Russia's reply to Defense Secretary McNamara's assertion that the U.S. will continue to maintain a survivable deterrent. The Marshal said: "With one nuclear rocket blow we could raze off the face of the earth any target, all the industrial and administrative political centers of the United States and destroy whole countries which have lent their territories for American military bases. . ."

Shots of the Week

A week billed by the press as the "greatest" in the history of the U.S. space program got off to a wobbly start.

First, NASA was forced to slip both the *Ranger* lunar hard-landing and *Mercury* manned orbital shots set for Jan. 22 and Jan 23, respectively, from the Cape.

Then the Navy fired a 1500-mile *Polaris A-2* on Jan. 23 which failed when the second stage misfired.

The next day: more misfortune. The Navy's first attempt at orbiting its *Composite I* payload of five satellites failed when there was another second-stage misfire—this time with a *Thor AbleStar*.

The *Composite I* payload contained four Navy satellites: A 58-lb. *Solar Radiation IV* to measure X-ray emissions; a 58-lb. *Lofti II* to study radio wave propagation; a new *Surcal I* to provide precise calibration for the Navy's space surveillance and tracking system; and a 59-lb. *Injun II* to obtain data on auroral phenomena. The fifth satellite was a new, 36-lb. device of the Army Engineers to provide range calibration data.

All the satellites dropped into the Atlantic south of Cuba.

By week's end, NASA was still hoping to get off the *Ranger* and *Mercury* flights.

On the military side the results were better:

An Air Force SAC crew, in a salvo exercise, fired *Titan I* elevated from a silo at Vandenberg AFB on Jan. 20.

On Jan. 24, a Martin *Mace B* was fired from a prototype hardened site at the Cape in a low-level flight test. The bird is nearing operational status.

Also on Jan. 24, the 30th test firing of an Army Martin *Pershing* was successfully carried out at the Cape, testing the warhead's fuzing and arming (see story, p. 15).

JFK Lauds Sites Cooperation

President Kennedy said last week that "every missile-site project is expected to be completed on time or ahead of schedule" because of the cooperation between labor, management and Government.

His remarks were in a letter read by Labor Secretary Goldberg at ceremonies presenting certificates of merit for early completion of *Atlas* bases.

Goldberg presented the certificates to 22 labor, management and government members of missile-site labor relations committees at Forbes AFB, Kan., and Warren AFB, Wyo. The Forbes installation was completed three weeks ahead of schedule, Warren five weeks early.

Artemis Sonar Work Reported 'Promising'

Progress is reported in the Navy's Project *Artemis* development of long-range sonar.

M. W. Johnson, manager of Columbia University's Hudson Laboratories, describes the sonar work to date as "promising." Hudson, with a $2.3-million contract, is one of 30 research groups participating in *Artemis* for the Office of Naval Research.

The project is directed mainly toward devising equipment and techniques to use "sound channels" found in the ocean to locate submarines at remote distances. Hudson is working on a data-collection system that will filter significant sounds from the ocean's background noise.

Helping in this work is a high-frequency sound generator—as tall as a five-story building—which can be raised and lowered into the sea. It is said to use enough electrical power to supply a town of 50,000 people.

Renegotiation Extension Bid

Congress is being asked by the Renegotiation Board to extend the Renegotiation Act for another four years. The present law is due to expire on June 30.

Board Chairman Lawrence Hartwig is requesting that the law be renewed unchanged, contending that DOD pricing policies still "cannot in all cases guarantee against excessive profits."

Consideration of the bill is expected to be deferred by the House Ways and Means and Senate Finance Committees until June.

Aerojet Wins $90-million M-1 Award

NASA has taken another major step in its manned lunar flight program with the award of a $90 million contract to Aerojet-General Corp. to develop the 1.2-million-lb.-thrust M-1—a hydrogen-oxygen engine to power Nova second stages (M/R, Jan. 1, p. 10).

Four M-1 engines will be clustered to produce a total stage power of 4.8 million lbs. Each engine will measure 23 ft. in length, 15 ft. across at the nozzle exit and consume 85 tons of propellant in 1 min.

The space agency also said that the third stage of Nova will be powered by a single hydrogen-oxygen J-2 engine, which produces 200,000 lbs. thrust and is under development by the Rocketdyne Division of North American Aviation, Inc. The first stage of Nova already has been fixed at a cluster of eight Rocketdyne F-1 engines, each developing 1.5 million lbs. thrust and fueled with oxygen and kerosene.

In awarding the M-1 contract to Aerojet, NASA skipped its usual competitive procedure. The agency said Aerojet was selected "following detailed discussions with aerospace companies having considerable experience in large liquid-fuel engine work. The decision was made on the basis of technical competence, lowest cost and least time required to complete the work."

The engine—largest of its type—is to be ready for operational use in 1965. Aerojet will perform the work at its Sacramento plant. NASA's Marshall Space Flight Center will negotiate and administer the contract.

hallicrafters Publishes "Electronic Warfare Spectrum" Chart—Which Instantly Shows the Newly-Revised ECM Frequency Band Authorizations!

The complex, two-year revision of the defense regulations entitled "Performing Electronic Countermeasures (ECM) in the United States and Canada"—published 7 September 1961—is now available.

All military and non-military government agencies coordinated in the project. Official regulation numbers are:

AIR FORCE REGULATION NO. 55-44

ARMY REGULATION NO. 105-86

OPNAV INSTRUCTION 3430.9A

NAVMC 1180 (REV 8-61)

What the new "regs" cover

They contain the frequency band authorizations, geographical restrictions, alerting requirements, and in-flight procedures that govern the performance of active airborne countermeasures (ECM) in the United States and Canada. They establish a procedure for the local clearance of frequencies for ground and shipboard operations plus additional in-flight frequencies not otherwise authorized.

Vital to all services

The new regulations apply to:

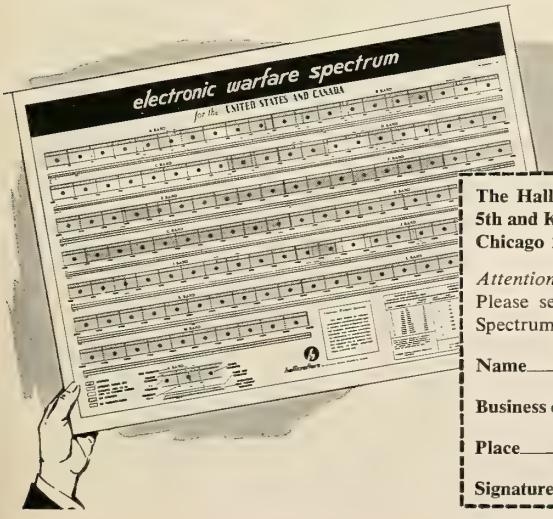
A. All military organizations performing in-flight ECM operations over the U.S. and Canada.

B. Civilian contractors performing in-flight ECM operations over the U.S.—but not Canada—provided the contractor meets the following criteria:

1. The contractor is currently under a military contract that requires performance of in-flight ECM operations.
2. The ECM equipment to be used by the contractor has been contracted for or is owned by the Government; and
3. A military resident representative is available to supervise the contractor on the use of the provisions of the new regulations.

Hallicrafters "Electronic Warfare Spectrum" Chart is 22½ by 34½ inches in size, and is printed in many colors—for rapid visual scanning. It shows the "Electronic Warfare Operational Bands and Channel Codes"; the "International Radio Communication Frequency and Wavelength Bands", as well as "Former Band Designations".

Hallicrafters is proud to offer this important chart as a service to our defense forces and industry. Write today for your free copy.



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Pershing Near Production Phase

Program estimated to cost $1 billion will give Army one of world's most mobile big systems

by James Baar

THE *PERSHING* missile system production line is about to begin moving.

First production prototypes are expected to be launched from Cape Canaveral in the near future; the first nuclear-tipped operational models are expected in the field later this year.

The Army and Orlando Aerospace Division of Martin Marietta, *Pershing* prime contractor, opened the final phase of the R&D program Jan. 16 with the successful launching of the first all-but-tactical *Pershing*. (A second was fired successfully on Jan. 24).

The lance-shaped missile, stripped of its usual range instrumentation section, roared down the Atlantic Missile Range farther than any previous *Pershing*. The impact point was unofficially reported to have been about 400 nautical miles away—some 50 miles more than the missile's expected operational range.

The all-but-tactical *Pershing* looked exactly like the late R&D models except that it was about four feet shorter because of the absence of the range instrumentation section. The new model also was lighter.

Earlier R&D models have undergone three configuration changes involving either the second stage or the nose cone.

• **Fast development**—The rapidly culminating *Pershing* R&D program is generally considered to have set one of the best records in the history of U.S. missilery.

Martin received the prime R&D contract in March, 1958. The first *Pershing* was delivered for testing in one year; the first flight-test took place in just under two—on Feb. 25, 1960.

Of 30 R&D launchings, 26 have been successful — including the last ten; one was a partial success; three were failures. The last failure took place in May, 1961; the partial success in August, when a malfunction developed in the second stage.

All *Pershing* launches have been from the missile's highly-mobile TEL — Transporter-Erector-Launcher. The TEL has been emplaced either on a concrete slab or on the missile's tracked XM-474 prime mover, which has a maximum speed of 40 miles an hour.

• **'62 forecast**—Here is the outlook for the *Pershing* program over this year:

—The missile production line is now being set up at the Martin Marietta plant in Orlando. Prototype production models are expected to be launched within the next few months.

—Training of *Pershing* cadres has been under way since September. Classes for *Pershing* batteries are being set up at the Army Ordnance Guided Missile School at Huntsville, Ala., and the Artillery Missile School at Fort Sill, Okla. Batteries—probably four to a battalion—will be activated at Ft. Sill.

—Evaluation tests of the system in the field under various conditions have already begun. Testing sites tentatively include: White Sands Test Range, N.M.: Aberdeen Proving Ground, Md.; Alaska; Eglin AFB, Fla.; probably Panama; possibly Pt. Arguello, Calif.

—Exact deployment dates are still highly classified. However, the first *Pershing* batteries are expected to begin joining U.S. forces in Europe before the end of 1962, if not earlier. Deployment unquestionably could be speeded if the Cold War should worsen.

The Army has given no public indication to date as to how many *Pershing* batteries it plans to deploy over the next several years. The total planned procurement of *Pershing* bat-

THE PERSHING SYSTEM

The Missile:

Length *about 30 ft.*
Diameter *40 in.*
Weight *Not available*
Guidance *Inertial*
Propulsion *Solid (two stages)*
Warhead *Nuclear*
Range *about 350 n. miles*

Principal contractors: *Martin, prime; Thiokol, propulsion; Bendix/Eclipse-Pioneer Division, guidance; Bulova Research & Development Labs, Inc., fuzing and arming; (Collins Radio, communications)*

The Transporter-Erector-Launcher (TEL):

Length *about 19.3 ft.*
Width *about 6.5 ft.*
Height *about 8.6 ft.*
Weight *about 5800 lbs.*

Principal contractor: *Thompson Ramo Wooldridge*

The Prime Mover (XM-474):

Length *18 ft.*
Width *8.3 ft.*
Weight *about 11,900 lbs. (fueled)*
Speed *40 mph*
Range *about 200 miles*

Principal contractors: *FMC, prime; Chrysler, Allison, engine*

R&D LAUNCHINGS: 30 (26 successful; 1 partial; 3 failures)

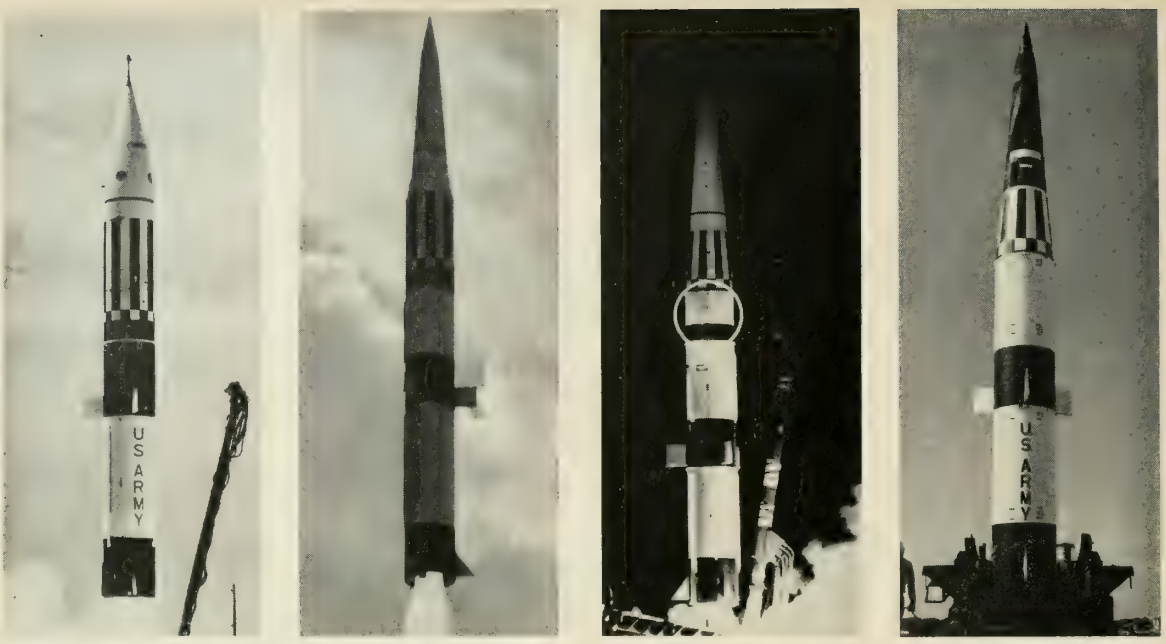


PHOTO SEQUENCE shows how flight models of Pershing have developed since 1960, with changes in second stage and nose cone. Note how range instrumentation section (circled in third photo) is missing from all-but-tactical bird (right).

teries by West Germany and possibly other NATO nations also remains to be determined.

However, it is clear that so far there are no signs the Defense Department will increase the long-planned production rate as part of the overall limited war build-up.

The Army and Martin built a considerable capability for expanding production into the *Pershing* program. However, no order to expand has been given.

• **Billion-dollar program** — To date the Army has awarded a total of about $155 million in production contracts for the *Pershing* system. Of this, Martin received $128.7 million, Bendix-Eclipse $23 million and Universal Match $2.5 million.

Pershing contracts for all other phases of the program to date total $480.5 million. That brings the grand total of contracts let on *Pershing* so far to $635.5 million.

Rough estimates considered by some to be conservative put the final total cost of the program from inception to full deployment at more than $1 billion. About half of this will be the cost of the R&D effort.

• **High mobility** — The *Pershing* when deployed on the European Central Front will confront the Soviet Bloc forces with one of the most mobile major missile systems in the world.

All of each *Pershing* firing unit—one battery—will be able to move on four XM-474 tracked vehicles. One XM-474 carries the TEL missile minus the warhead; one the communications equipment; one the power and fire control-check out units; and one the nuclear warhead and spare parts.

The tracked vehicles can not only move overland through rough country but also ford water three-and-a-half feet deep. They can be rapidly brought together for a launching and rapidly dispersed in order to survive on a nuclear battlefield.

In a recent demonstration, a battery manned by an eight-man crew including drivers emerged from a wooded area, assembled a missile, erected it for firing and assembled all other equipment in less than 10 minutes.

The demonstration did not include all steps necessary for launching. But the additional steps were not considered by people close to the program to be particularly lengthy ones.

The *Pershing* system's mobility has been increased still further by designing it for transportation by helicopter as well as fixed-wing aircraft.

An entire battery with the exception of the prime movers can be transported by YCH-1B Chinook helicopters. Moreover, batteries can be resupplied with missiles by Chinooks and with spare parts by smaller helicopters.

This tremendous increase in mobility can best be appreciated by comparing *Pershing* to the obsolescent *Redstone* that it has been developed to replace. Moving a *Redstone* has on occasion been compared to putting wheels on the Pentagon.

• **Low-budget GSE**—The *Pershing* system is designed to enable the Army to fight a sustained nuclear war on the ground. The battery GSE is an artillery piece that can be resupplied with shells with relative ease over a highly-organized logistics line stretching back to the United States.

Because of this, *Pershing* has broken from the missile-GSE cost trend found in the current procurement of major missile systems. The Army estimated that more than 70% of all procurement funds spent on the *Pershing* system will be spent on missile, less than 30% on GSE.

The Army estimate is based on GSE procurement that includes all equipment required to transport, launch, and maintain the system as well as support training. The estimate does not include helicopters or fixed-wing aircraft.

Technically, the future possible development of *Pershing* is considered to be great—both as a longer-range battlefield weapon and as a possible small and easily launched space booster. However, neither of these avenues is being pursued actively at present, either by the Army or the *Pershing* industrial team.

The Army has been forced to shelve proposals to develop a 1000-mile-range *Pershing II* by the Defense Department decision to assign the development of an advanced mobile MRBM by the Air Force.

All efforts in the *Pershing* program are directed toward putting the first batteries in the field on schedule. ⌗

In classified briefing . . .

McNamara Spells Out 5-Year Plan

CHAPTER II of the FY '63 defense budget—a 166-page highly classified explanation—is now before Congress.

The document, presented to the Senate and House Armed Services Committees by Defense Secretary Robert McNamara, offered far more illumination regarding his new five-year military program than did the original budget.

McNamara also used his appearance Jan. 19 to renew his previous pledges to reform Pentagon procurement practices. He reaffirmed that his goal is to cut costs while increasing competition, broaden the defense industry and make far greater profits possible (see below).

The Secretary testified in secret. However, a 107-page censored version of his statement devoid of some 40 pages of charts still yields considerable insight and detail of both the FY '63 military budget and the overall five-year plan.

Here, system by system, are the key items affecting missile/space programs:

Strategic Missiles

Atlas—"It may be desirable later on in the decade to start phasing out some of the soft *Atlas*" bases. (Four *Atlas* squadrons are soft; three, semi-hard; six, hard.)

Minuteman—"Additional squadrons will be procured in later years" beyond the 16 squadrons — 800 missiles — planned through the FY '63 budget request. The 16-squadron program "will not fully utilize the production capacity already built, (but) we still believe we should complete the expansion of production capacity started last year . . . because of a number of uncertainties . . ."

Polaris—"It is difficult to justify a *Polaris* force of more than 41 submarines." (The statement was a blow to Navy plans for construction of a fleet of 45 to 50 *Polaris* subs.) The budget requests $44.5 million "to begin construction and equipping" a West Coast *Polaris* Depot for *Polaris* subs operating in the Pacific. (Plans call for locating it at Bangor Naval Weapons Depot, Wash.) About another $10 million is requested for additional training and test facilities at the Charleston, S.C., depot and at Cape Canaveral.

B-70 Mach 3 bomber—The budget requests $171 million for continuing the B-70 R&D program in FY '63—bringing to $1.19 billion the total sought by the Administration to date. A $1.3-billion R&D program with no production is still the Administration plan. Air Force proposals to reorient the B-70 "to a reconnaissance strike vehicle . . . obviously will require a great deal more study . . ."

Air/Space Defense

Nike-Hercules — The budget requests $105 million for additional *Nike-Hercules* missiles to increase the strength of present batteries. The new money also is for the procurement of more of the improved *Nike-Hercules* radars and associated equipment.

Nike-Ajax—There are still 19 battalions operated by the Army National Guard. They will "gradually be phased out."

Nike-Zeus—"Well over $1.1 billion has been budgeted for this (R&D) program through FY '62 and a substantial sum is being requested for FY '63." However, "because of serious questions as to the practicality of the *Nike-Zeus* system, we are not recommending funds for its procurement and deployment at this time."

SPADATS — "Substantial funds were allocated to the Space Detection and Tracking System in FY '62 and an increased amount is included in this budget . . . These funds will support

(Continued on page 39)

How Pentagon Intends to Overhaul Procurement Practices

Defense Secretary McNamara's plan to increase competition in defense procurement:

"ADVANCE PLANNING: *Detailed planning is being initiated during the early design and development of an item to assure that the prerequisites for competition are anticipated and fully provided for. Steps have been taken to prevent noncompetitive procurement resulting from failure to contract for the timely delivery of technical data, failure to enforce such contract provisions, failure to inspect the data furnished and assure that it is of suitable quality, or failure to make appropriate use of the data now being furnished or which the Government already possesses.*

"REVIEW OF CONTRACTS AND PLANNED PROCUREMENTS—*Proposed noncompetitive contracts are being subjected to more stringent review at higher levels to determine whether the lack of competition is justified and, if so, to ascertain whether the factors responsible can be eliminated in time to permit competition for subsequent orders.*

"BREAKOUT—*Increased emphasis is being placed on breaking out from weapons systems those individual components and parts that can be bought competitively.*

"PUBLICITY—*We have revised our regulations to require all procurements over $10,000, with very few exceptions, to be summarized in the Commerce Business Daily. This gives interested firms who might otherwise not be known to us an opportunity to learn of these procurements and to participate.*

"LIMITATION OF QUANTITY ON INITIAL PRODUCTION—*In early production contracts in which competition is determined to be impracticable, we are stressing the purchase of the minimum quantity consistent with economy and military necessity (including test, evaluation, and standardization of design) in order to maximize the size of subsequent quantities purchased competitively.*

"IMPROVED STATISTICAL REPORTING—*We have revised our statistical reporting system to give more and better data on the trends in competitive and noncompetitive procurement. This information will help us identify the causes of noncompetitive procurement and enable us to take the necessary corrective action.*

"SPECIAL ATTENTION TO PROCUREMENT OF REPAIR PARTS—*A special effort is being made in the procurement of aeronautical replacement spare parts. If our goal of 30% competitive procurement can be attained, a savings in the order of $50 million annually is anticipated. A test of new procedures is now under way at three of our major inventory control points which manage aviation spare parts. After adequate testing these procedures will be applied throughout the Department.*

"COMPETITION IN SUBCONTRACTING—*Much of industry, perhaps to a greater extent than Government, has traditionally relied on sole-source rather than competitive subcontract procurement. By means of subcontract reviews, approval of make-or-buy programs, and surveys of contractors' purchasing systems, we are closely scrutinizing industry practices to ensure that competitive subcontracting is utilized to the maximum practicable extent."*

17 months behind Soviets . . .

18-Orbit Mercury Shot Off Until '63

by Hal Taylor

CAPE CANAVERAL—The first attempt at an 18-orbit manned *Mercury* flight is slipping into 1963.

This means that the United States will be at least 17 months behind Russia in achieving a manned spaceflight of more than 24 hrs. (Soviet Air Force Maj. Gherman Titov flew 17½ orbits in *Vostok II* on Aug. 6, 1961.)

NASA officials disclosed the new delay in the program as technical problems continued to plague the first U.S. attempt at placing a man into orbit last week. Moved back several times, *MA-6* —which was to carry Marine Lt. Col. John Glenn into a maximum 3-orbit flight—ran into new last-minute problems with a faulty oxygen demand regulator and a hose. Project engineers said tests showed this part of the system might have caused "excessive" oxygen consumption if the capsule suddenly lost pressure in space.

As M/R went to press the flight, previously scheduled for Jan. 24, had been reset for Jan. 27 barring bad weather or further technical difficulties.

The pre-launch gloom was further deepened by the failures of a *Polaris A-2* and the Navy's 5-in-1 *Composite I* satellite shot (see Shots of the Week, p. 12).

• **Late '62 delivery**—News of the slippage in the 18-orbit flight program was disclosed at the same time NASA officials reported that they now expect the first *Mercury* capsule modified for these longer flights to be delivered late this year. Earlier, the first 18-orbit flight had been scheduled for the fourth quarter of 1962.

Preflight checkout and minor technical problems which are almost certain to be encountered, NASA officials say, are likely to push the day-long flight into 1963.

Just as in the current *Mercury* 3-orbit series, NASA has scheduled four 18-orbit flights. But also as in the current series, if the first two launches are successful, it is likely that the remainder will be dropped.

The modification by McDonnell Aircraft Corp. involves the creation of more space within the capsule for an enlarged environmental control system which provides the spacecraft cabin and the astronaut with a 100% oxygen environment to furnish breathing, ventilation and pressurization gas during flight.

PREPARING FOR delayed launch, Astronaut John Glenn runs through preflight rehearsal of his entrance from top of gantry tower into MA-6 capsule.

The system is completely automatic and consists of two individual control circuits (the cabin circuit and the suit circuit) which are pegged to operate for about 28 hours.

This is far more than is necessary to support the *MA-6* flight, which was to last no more than 4¾ hours. It is very marginal, however, in terms of an 18-orbit flight.

Accordingly, NASA officials have decided to remove the periscope and back-up tape recorder from the capsule. The additional room within the capsule will be used to house additional batteries and oxygen to provide far more than the required life support for the 18-orbit mission.

• **Saturn pad** — Meanwhile, MISSILES AND ROCKETS also learned that NASA is preparing to award some $170 million in contracts during Fiscal 1963 for construction at Cape Canaveral of its Advanced *Saturn (C-5)* launch complex.

The facility will use a two-mile-long canal to transport the large launch vehicle from the vertical assembly building (VAB) to launch site. The *C-5* will be carried on barges 32 ft. high, 100 ft. wide and 150 ft. long.

Besides the barge award, contractors will also be selected for construction of the vertical assembly building and a cryogenics facility.

The barge contract will probably involve three separate contractors—one for the barge itself, one for the arms which will secure the vehicle, and another for the umbilical tower which will be used during launch preparations.

There still has been no decision as to the number of barges which will be required. NASA officials say the minimum number is four, but it is likely that six or eight will be required.

The final number will depend on the number of bays in the VAB because one barge will be required for each bay.

The *C-5* complex will have three launch sites. The self-propelled barge will move through the canal to the site and the big booster will be fired directly from it. Each launch site will have cryogenic facilities capable of storing all of the propellants required by one of the giant vehicles. There will also be a facility for the manufacture of liquid oxygen.

• **20-30 shots per year**—Contracts for the construction of the VAB will be awarded for NASA by the Army Corps of Engineers. In addition to bays for assembling the five-F-1-engine first stage, it will also have bays for the *S-II* second stage and the *S-4B* third stage.

(Continued on page 36)

Capsule Built for Circulation Study

by Heather M. David

THE NATIONAL Aeronautics and Space Administration is constructing a prototype primate satellite to determine the effects of spaceflight on the circulatory system and heart.

Great concern has been expressed by physicians that continuous exposure to weightlessness might significantly alter the functioning of the circulatory system. They fear these changes might be dangerous or fatal to the astronaut upon re-entry or return to normal gravity.

The NASA project aims to develop a technique to study the blood circulation of primates before, during and after sojourns of up to 14 days, in an earth-orbiting satellite.

According to project head Prof. Nello Pace of the University of California, there are lines of evidence which indicate that weightlessness may have far-reaching consequences:

1) Test results of healthy young men who were forced to stay in bed for three to four weeks. The most striking finding was a marked deterioration of cardiovascular function and clear evidence of reduced heart size. Dr. Pace likens the effect of bed rest to weightlessness.

2) The Russian dog Laika's pulse rate took substantially longer to stabilize after takeoff of *Sputnik II* than it did in comparable preflight centrifuge experiments on the same animal.

3) Experiments in high-speed aircraft showed that if weightlessness maneuvers were avoided, recovery from blackout (from high g loads) was more rapid. Pace said that both these reactions implied a sluggishness in the response of the homeostatic mechanisms which regulate the circulation of the blood.

In addition, studies of chronic exposure of animals to increased accelerative forces show that substantial changes occur. It would not be unreasonable to expect that changes might also occur during prolonged exposure to less than 1 g.

• **Research vehicle** — The NASA capsule is being designed and built by a group at the University of California. It will accommodate a trained, restrained primate such as a pig-tailed macaque or a young chimpanzee.

It will contain apparatus necessary for measuring heart rate, systolic and diastolic arterial blood pressure, great vein blood pressure and cardiac output. Electrocardiogram, respiratory rate and body temperature also will be monitored.

The Technical Support Directorate of the Pacific Missile Range at the U.S. Naval Missile Center, Point Mugu, Calif., is carrying out engineering design and construction of the mechanical system, under subcontract with the Bio-Science Office of the Pacific Missile Range.

The measurement technique was described at the American Astronautical Society Lunar Flight Symposium at Denver Dec. 29. Pace told the group that the key was to measure volume output rate of the heart, and simultaneously measure arterial blood pressure and heart rate.

To make this measurement, a dye is injected at or very near the blood intake point of the heart. Then measurement is made to find the average concentration of the dye in the arterial blood as it leaves the heart. Thus the amount of blood which was pumped by the heart can be computed by determining the amount that the dye has been diluted.

This technique has been made automatic to a great extent by the California group, with instruments developed mostly by Dr. J. T. Hansen, Assistant Research Physiologist. The group has successfully experimented for two years with dogs at UC's White Mountain Research Station.

Pace said that it is feasible to use the study method in earth-orbiting vehicles. He also noted that the use of catheters in the arteries and veins of the animal would make it possible to get a direct blood pressure reading.

• **Brain monitoring** — A UCLA medical center physician (and PH.D.) said that a tremendous volume of valuable information is going to waste because the U.S. does not monitor the electroencephalogram (brain waves) of its manned flight astronauts. Dr. W. D. Winters of UCLA's Space Biology Laboratory said that the Russians have found this technique quite valuable.

Winters said that the use of EEG measurement would enable ground physicians to continuously evaluate the conscious and unconscious states of astronauts. The standard measurements, respiration rate, electrocardiogram, pulse, etc., will not adequately differentiate between blackouts and sleep, or show small seizures.

The UCLA group is developing techniques for the use of stable immovable scalp electrodes for manned spaceflight. It also has developed implanted electrodes for the brains of cats and monkeys. These electrodes did not appear to cause any brain damage or affect the animals in any degree.

Some of the uses of EEG in spaceflight would be:

1) Distinguish between blackout and sleep.

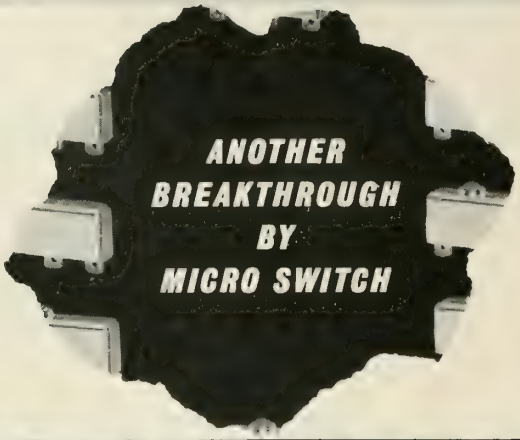
2) Indicate the widespread epileptic seizure discharges during blackout accelerations. Indications of a seizure would account for disorders of judgment occurring at this time.

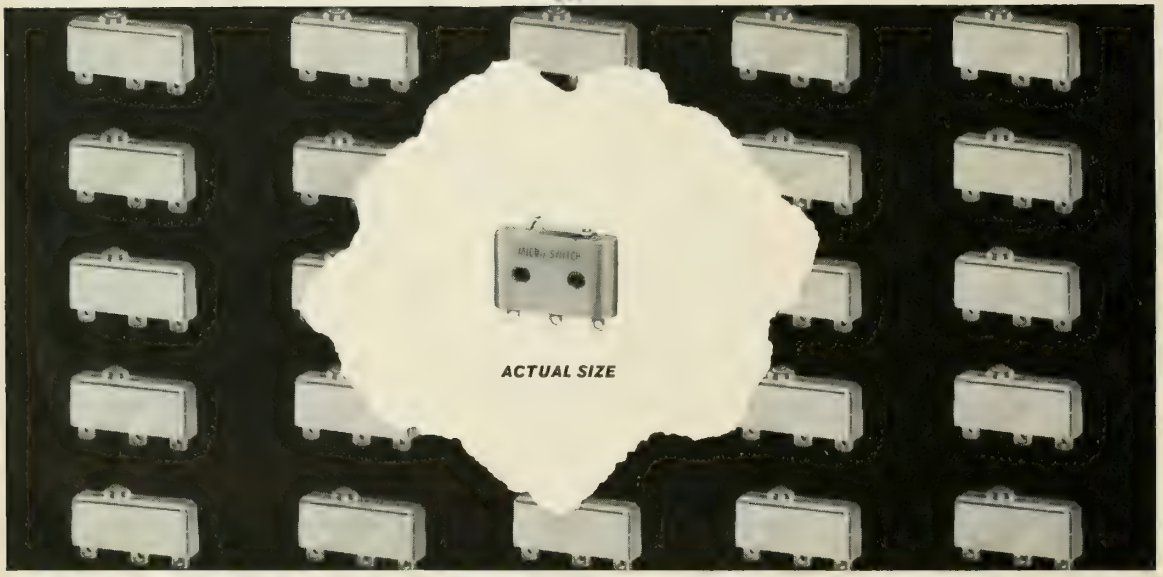
3) Indicate the effect of ionizing radiations. The temporal lobe regions of the brain apparently show a differential susceptibility to ionizing radiations.

Results of a 14-day simulated moon journey were given as an example of the value of EEG. During part of the test, the monkey was very inattentive and made a number of mistakes in his psychomotor tests. Since there was no alteration in electrical brain activity, the researchers were able to rule out central nervous system disorganization or seizure activity. They were able to attribute his poor performance to inattention.

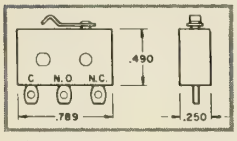
The researchers told the AAS that the technique of implantation of electrodes in animals can be made sufficiently rugged to withstand the rigors of repeated high centrifugal loads and shaking stresses. They said that after many months of repeated centrifuging, the animals had no displacement or damage from electrodes in the brain. ⁂

MICRO SWITCH Precision Switches





HERMETICALLY-SEALED SUBMINIATURE SWITCH *INTERCHANGEABLE WITH EXISTING SUBMINIATURE SWITCHES (MS 25085-1)*



The new MICRO SWITCH "HM" Series was developed primarily for military applications, such as missiles, rockets, spacecraft and electronic equipment. It is interchangeable with existing (MS 25085-1) subminiature switches in size, mounting, and characteristics. Designed for use with standard auxiliary actuators and in push-button, toggle and rotary-actuated switch assemblies. Meets explosion-proof requirements of MIL-E-5272.

Temperature Range: *The case is welded or high-temperature brazed to assure reliability and long life of the switch in temperature ranges from —300°F to +250°F.*

Hermetic Seal: *The seal at the actuator diaphragm and around the mounting holes is by metal-to-metal fusion. The terminals seal is glass-to-metal. This provides a true hermetic seal. The switching element chamber is evacuated, filled with inert gas, sealed, then checked by a mass spectrometer.*

Corrosion Resistant: *Stainless steel construction of all exposed parts meets corrosion resistant requirements of MIL-S-6743.*

Circuit: *Contact arrangement is single-pole double-throw.*

Rating: *Electrical rating is 3 amps inductive and 5 amps resistive at 28 vdc. Especially suitable for low-energy circuits and for long shelf-life requirements. Minimum mechanical life is 25,000 operations.*

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MICRO SWITCH Precision Switches

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Technical Countdown

SUPPORT EQUIPMENT

British To Build Two Radio Telescopes

The British government has approved construction of two radio telescopes for space research—one at Jodrell Bank and the other at Cambridge. The Jodrell dish, 125 ft. across, will be used in conjunction with the 250-ft. telescope to determine the exact source of radio emissions from space. The Cambridge telescope will consist of three 52-ft. dishes —two of which will be fixed, the third rail-mounted. It will be used to examine the intensity of radio sources in a limited part of the sky. Expected to be operational by 1964, the telescopes are being constructed under grants from the British Department of Scientific and Industrial Research.

Rocket-Armed Helicopters Being Tested

Under the overall direction of the Transportation Corps and the technical management of the Army Ordnance Missile Command, the Army is conducting a test program of aircraft armament for helicopters. Using the Bell HU1-B, AOMC engineers have mounted two weapons pods (one on each side of the helicopter body) with 24 2.75-inch, folding-fin aircraft rockets in each pod. The rockets can be fired in pairs—giving the pilot a capability of 24 shots.

ELECTRONICS

EOS Developing Improved Solar Cell

A solar cell which will withstand the radiation effects of space is under development by Electro-Optical Systems, Inc. The cell, expected to have an efficiency of 11% or better, will have a graded base structure—the doping more dense at one end of the cell than the other—as the principal means of overcoming the effects of radiation damage.

Low-Temperature Fuel-Cell Under Development

An ARPA-Army sponsored research contract has been awarded to the Esso Research and Engineering Co. for work on an advanced, low-temperature fuel-cell. Designed to use methanol or ethylene glycol for fuel, air as oxidant, and an electrolyte which rejects the products of reaction, the fuel-cell system also operates at essentially atmospheric pressure and does not require replacement or regeneration of the electrolyte.

Thiokol S&A Device Proven Reliable

An electromechanical safe and arm device designed and developed by Bristol Division, Thiokol Chemical Corp. for the Air Force's *Titan II* destruct system has successfully completed flight certification tests, according to company officials. Remotely actuated, the safety device is reported to have a firing reliability of better than 0.999975 at a 95% confidence level.

Ultrasonic Sound Rendered Audible

Sound in the ultrasonic range can be picked up and converted to the audible range with a unit that simultaneously rejects all audible background. The devices, manufactured by Delcon Corp., are designed to detect minute leaks in pressure vessels.

Arnold Tunnel Gets Power Supply

A 100-million joule d-c pulse generator is in operation at the Air Force's von Karman Gas Dynamics facility, Arnold Engineering Development Center. The GE unit will power a large hypersonic wind tunnel designed to test full-sized nose cones and other large vehicle components.

Automatic Microwave Interferometer Perfected

General Dynamics/Pomona has developed an automatic microwave interferometer that reduces the time needed to measure phase shifts through a radome. The unit can be adapted to check microwave phase shift versus any variable and to measure continuous data for a full 360° in only 20 seconds.

ADVANCED MATERIALS

Aluminum-Fiberglass Cases Developed

High-strength aluminum reinforced by fiberglass is the newest technique being advanced in the solid-rocket pressure-vessel area. Martin Marietta engineers say the one-piece design would save tens of millions of dollars in current missile systems alone. The method is also being suggested for the large solid-booster concept.

G-D Applying Air Bearings to Plant Operations

Loads up to 15,000 lbs. can be moved with a single-finger push at General Dynamics/Astronautics plant. The bearings are being used to move massive equipment, to carry straight-line welders, as part of weightlessness studies, and as protective cushioning in forming operations. Operating cost of the equipment is low—moving an 1800-lb. machine continuously during an eight-hour shift runs to 2.5¢.

Polaris Bagged in Flight

A heavy-duty nylon-webbed net is being used by Lockheed to snare advanced versions of the Navy's *Polaris* missile in mid-air. The huge bag captures the 15-ton IRBM as it breaks from the water after being launched from Lockheed's submerged tube.

SPACE MEDICINE

Acceleration Cuts Astronaut's Visibility

Cornell Aeronautical Laboratory scientists have established a definite relationship between acceleration and an individual's visual perception of brightness. Four background brightness levels were studied. Under normal conditions, subjects required an average of 9% contrast to see the light spot. A 5-g force in the head-to-nape direction increased this to 11% and the same force in the head-to-foot direction raised the level to 17%. Oxygen intake may reduce or eliminate these losses.

Enos Hypertense in Flight

A blood-pressure recording device developed by the University of Southern California definitely establishes that the orbiting chimp was hypertense at the start of his trip. The condition lasted until his recovery, but did not seem to interfere with his performance in spite of the malfunction of the shock-penalizing system.

THE QUIET MEN

Today, we're united in one of the hardest fought crusades the world has ever seen —the all-out assault on every frontier of scientific knowledge. Yet the beginnings of these ventures are not marked with fanfare. The battles and victories are often fought and won in complete loneliness by a single man... or by groups of men sharing their knowledge. From their quiet yet unrelenting research efforts come the theories that one day make the headlines.

Never before have such men been so needed; never before has their stimulus been so great; never before have their findings been so significant.

Our nation's investment in military and scientific research alone is already yielding dividends in terms of America's economic growth. Many of the new jobs, products, services, and even industries that today loom large on the American scene are the fruits of ideas put to work in the last decade.

Since its earliest days, America's aviation industry recognized the significance and need for extensive research activities. Today the aviation industry is better known as

the aerospace industry. No longer is it known only for its leadership in aircraft; it is now recognized as a dynamic force in many other fields: chemistry... computers... nuclear energy... communications... life sciences... electronics... propulsion... naval technology... navigation.

Through this research and diversification, the aerospace industry is contributing to the advance of the Free World's scientific progress. And here—as in all American industry—the quietest roles are often played by the men of science whose accomplishments are bettering the lives of all.

These are the men of research... the men whose vocabulary does not include the word "impossible."

These are the quiet men.

North American Aviation is at work in the fields of the future through these six divisions: Atomics International, Autonetics, Columbus, Los Angeles, Rocketdyne, Space & Information Systems.

Ultrasonic Conquering Refractories

Vibration welding process can join all high-temp materials; thickness capability grows

by John F. Judge

WEST CHESTER, PA. — Ultrasonic welding is being actively pushed by the Air Force as the best approach to joining superalloys and the refractory metals.

H. L. McKaig, Jr., Manager of Advanced Technology at Aeroprojects Inc., says the state of the art in the process is well beyond thin-foil applications. Ultrasonic welding is now at a point where it can handle most of the structural gages being considered for space use.

The firm currently has an Air Force contract to continue development in the welding process. Recently, the Air Force Space Systems Division requested Aeroprojects to stage a presentation on ultrasonic welding for over 150 representatives from West Coast contractors.

All of the refractories have been welded and the firm has volumes of data available to back this claim.

• **Process underestimated** — These developments are at variance with the findings of a report currently being circulated by the Office of Technical Services of the Business and Defense Services Administration.

The report concludes, among other things, that research into ultrasonic welding of heat-resistant metals ". . . appears to preclude the use of the ultrasonic welding process for reliable welds".

This conclusion was reported in this magazine (M/R, Dec. 11, p. 21) and is appearing in other publications.

COMPARISON of welds in molybdenum points up contrast in grain size in fusion weld (below) and ultrasonic joint (above). Ultrasonic weld did not reach recrystallization temperature. Vibration weld tends to avoid anisotropic properties.

Results of the investigation, conducted by the Battelle Memorial Institute under Air Force sponsorship, were published about a year ago. Aeroprojects experts feel the conclusions were somewhat overly pessimistic.

Many of the controversial material combinations investigated at Battelle have been welded by Aeroprojects.

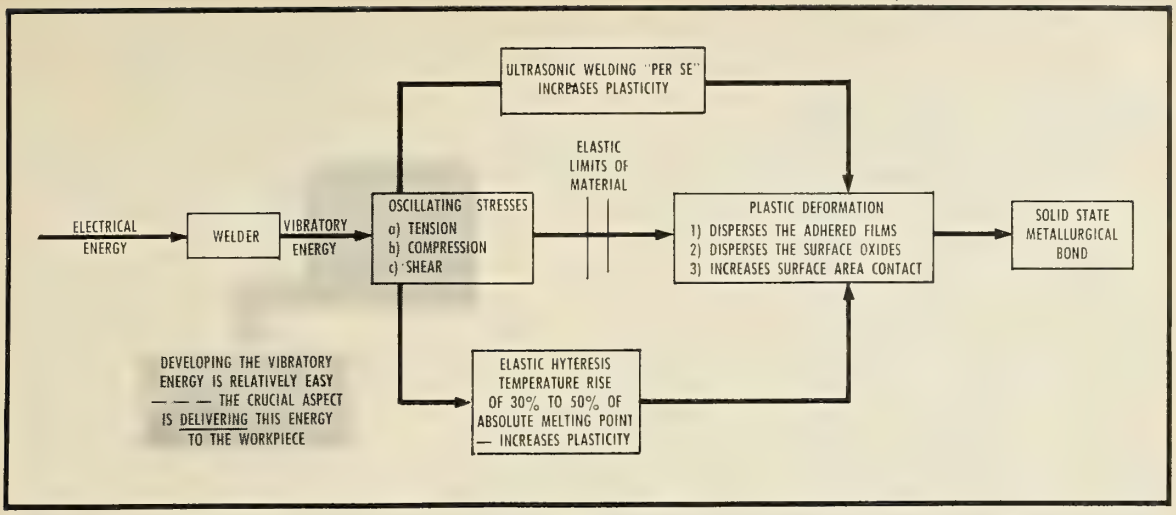
The firm is now working on welds up to 0.10 in. thick in tungsten, and equipment is being developed. Aeroprojects holds most of the basic patents in the field and the majority of improvement issues. Product and processes are included in these patents. The process is an established success in the electronic component fields.

• **Untapped potential** — The vast majority of improvements in the art of welding have come about in either thermal energy control or atmospheric control, or both. The pinnacle is probably the development of electron beam welding — reaching almost atom-by-atom control in a vacuum.

Ultrasonic welding avoids both problems. In most metals there is no thermal condition effect and atmosphere has no bearing. This is not to say that no new problems are created—Aeroproject experts readily point to many obstacles, but these do not appear to be fundamental to the process.

Ultrasonic welding is basically a process for joining metals by introducing high-frequency vibratory energy into overlapping workpieces. A brief transmission of this energy into a workpiece under moderately low static force will produce a sound metallurgical bond.

This joint is effected without fluxes or filler metals, without arc, electrical transmission or melting of the weld metal. There is no cast structure and


ULTRASONIC WELDING "PER SE" INCREASES PLASTICITY
ELASTIC LIMITS OF MATERIAL
ELECTRICAL ENERGY
WELDER
VIBRATORY ENERGY
OSCILLATING STRESSES
a) TENSION
b) COMPRESSION
c) SHEAR
PLASTIC DEFORMATION
1) DISPERSES THE ADHERED FILMS
2) DISPERSES THE SURFACE OXIDES
3) INCREASES SURFACE AREA CONTACT
SOLID STATE METALLURGICAL BOND
DEVELOPING THE VIBRATORY ENERGY IS RELATIVELY EASY
— — — THE CRUCIAL ASPECT IS DELIVERING THIS ENERGY TO THE WORKPIECE
ELASTIC HYTERESIS TEMPERATURE RISE OF 30% TO 50% OF ABSOLUTE MELTING POINT — INCREASES PLASTICITY

PRINCIPAL FEATURES of ultrasonic welding are evident in this process schematic. Plasticity factors provide an increased area of intimate, clean surface contact generating true solid-state bond. Process cannot handle butt-welds.

only negligible thickness deformation. This deformation affects the surfaces of the welded parts only by 1 or 2% of the total weldment thickness.

Welding occurs when the tip, clamped against the workpiece, is made to oscillate in a plane parallel to the weld interface. The combined static and oscillating forces introduce dynamic stresses in the metal, producing elasto-plastic deformations which effect a moderate temperature rise in the weld zone. Material properties in the weld zone are transiently altered and a solid-state bond is achieved.

The energy is originally drawn from an electric power line. It passes into an electronic generator or rotating-machine device converting the 60-cycle line power to the desired frequency of operation. The high-frequency current is then delivered to a transducer which converts the electrical power into acoustic power at the same frequency. This is the easiest and least complicated section of the process, say Aeroproject experts.

• **Engineering problem**—Delivering this acoustical energy to the workpiece in a productive manner is the heart of the ultrasonic welding technique. There are a wide range of factors in this energy delivery—presenting a complex problem in acoustical engineering. Merely dumping the energy into the workpiece usually means no weld.

Part and parcel of this delivery system is the application of clamping force in such a manner as to avoid affecting the frequency. If this is not accomplished, the resonant frequency of the system may shift to such an extent that matching or tracking of the frequency with the power supply may be difficult or impractical. A second disadvantage is that enough energy may be lost to the mounting system so that very little is delivered to the welding zone.

These problems were solved through development of a force-insensitive mounting system. This mounting method, and its subsequent improvements, made ultrasonic welding a practical process.

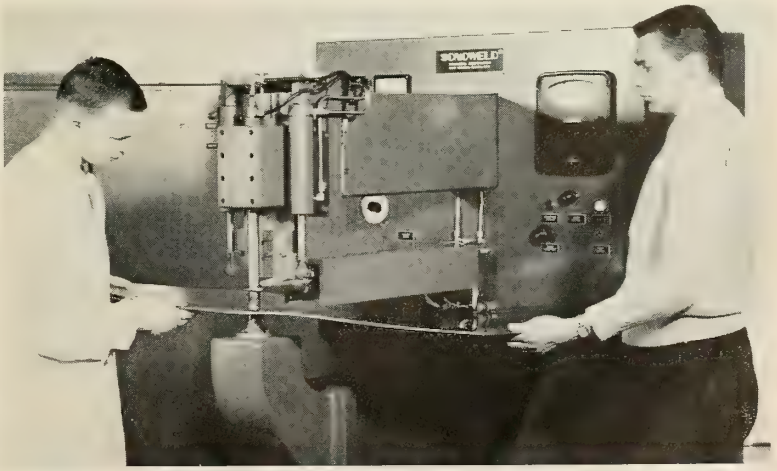
In the wedge-reed welding system, the transducer-coupling system excites a flexural vibration in the reed. The reed itself is part of the clamping system, and vibration isolation is achieved because no energy is delivered to the mounting end of the reed. This reed serves as an intermediary in carrying the lateral vibration to the workpiece and as a means of attaining force insensitivity.

Another clamping mechanism, developed by W. C. Elmore, basically consists of a metal cylinder 0.5 wavelengths long at the design frequency. This sleeve encircles a portion of the coupling member with one end permanently attached to it. The rest of the cylinder, being attachment-free, is also free to vibrate.

A flange extends radially outward from the cylinder at a point 0.25 wavelengths from the free end. The transducer-coupling system may be force-insensitivity hinge-supported by securing the flange to a pivot, or it may be otherwise supported through this flange.

The Elmore Mount is based on the principle that, when a one-half wavelength vibratory device has a free end (an end not delivering energy), a true acoustical node will exist at a location 0.25 wavelengths from the free end.

Since minimum motion of a vibratory device occurs at a node, this is an optimum location at which to secure attachments to the vibrating system. A true standing wave pattern is set up in



COMPLETELY AUTOMATIC 4000-watt welder is typical of the minimum-size unit needed to adequately handle refractory metals and superalloys.

the mount because of the transmission of vibratory energy from the air boundary at the free end.

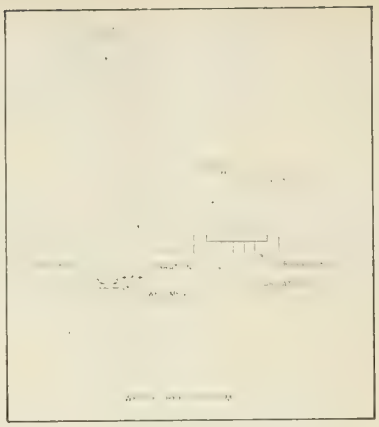
Nodal supports have previously been used in conjunction with vibratory devices involving attachments to the coupling itself at a supposedly nodal location. But Aeroproject engineers say it was not recognized that a standing wave pattern does not exist on a transducer-coupling system which is delivering essentially all of its power. Hence a true acoustical node likewise does not exist.

Because the Elmore Mount is part of the vibratory system and yet separate it achieves its function of providing force insensitivity.

• **Theory advanced**—Aeroprojects is probably the most advanced firm in the U.S. in the field of ultrasonic welding. Research into the mechanisms involved in the many aspects of ultrasonic welding is carried out within the parent firm. A subsidiary, Sonobond Corp., serves as the marketing arm.

In one instance, researchers have evolved a rule of thumb which leads to an estimate of the power needed to weld materials based on a relationship between the thickness and the Vickers Hardness values. It is still holding true up to 12,000-watt/second applications. But there are other crucial factors. This guide does not define the threshold level of the workpieces, the level which defines the strain needed to exceed the elastic limit of the workpiece.

In any event, the guide does serve as an approximation of the minimum energy needed in a given case.



FORCE-insensitive mounting system applied to wedge-reed welding concept still permits shear mode of vibration. Process is particularly adaptable to electronic systems manufacture involving microcircuitry attachment.

Energy rate is extremely important. Taking a low energy and a long application time can result in too much heat and unnecessary stress in the weld area. The end result is no weld or a poor joint.

Short intervals at high power rates, within certain limits, is the desirable approach.

J. M. Peterson of Sonobond says the watt/second product cannot be sliced in an arbitrary manner—and this is especially true when working with superalloys and refractory metals.

Although the energy rate for any given material can be estimated, it is generally true that short pulses make good welds—granting sufficient power. Another general rule is that the so-called exotic materials can be welded to exacting standards through maximum power/minimum time approaches.

As far as the welds themselves are concerned, the ultrasonic joint in aluminum alloys is as good as resistance welds in fatigue tests beyond the 105 cycle level. At lower cycles, the ultrasonic weld data is higher for given lifetimes. The ultrasonic weld can hold its own when measured against conventional welding specifications. The Russians claim a 30% improvement in certain areas through ultrasonics (see box).

Hardness is a pertinent point in the properties of weldable materials. In general, high powers are required and the resultant weld areas are smaller. Weld are most readily achieved in dissimilar metals if the hardnesses are not too far apart.

Work with the process shows that elastic modulus and shear strength are important and the effects of transient heat on these properties are significant. But none of these represent fundamental problems in the process.

A family of ultrasonic welding equipment is being marketed by Sonobond. Spot welders include 20-, 100-, 300-, 600-, 2000-, and 4000-watt machines. Seam and ring welders also are available in different powers. ⁂

Russians Deep in Ultrasonic Welding

ACTIVE PROGRAMS in ultrasonic welding process are in progress at various institutes throughout the Soviet Union. Here is an up-to-date list of Russian-published work in the field.

Kitaigorodskii, Yu. I., M. G. Kogan, V. A. Kuznetsov, N. N. Rykalin, and L. L. Silin, "Joining of Metals in Solid State by Ultrasonic Vibrations." Izvestiya Akademii Nauk SSSR, Otdelenie Teknicheskikh Nauk, August, 1958, pp. 88-90. (Henry Brutcher Translation No. 4401)

"Ultrasonics in Soviet Welding Practice." Svarochnoe Proizvodstvo, September, 1958, p. 24. (LC Translation No. 59-22268)

Ol'shanskiy, N. A., A. V. Mordvintseva, and M. N. Krumboldt, "The Use of Ultrasonics in Seam and Spot Welding." Avtomaticheskaya Svarka, Vol. 11 (October, 1958), pp. 75-80. (LC Translation No. 60-15654)

Ainbinder, S. B., "Certain Problems in Ultrasonic Welding." Svarochnoe Proizvodstvo, Vol. 32 (December, 1959), pp. 4-6. (Translation: Welding Production, December, 1959, pp. 10-18)

Makarov, L. O., "Scientific-Technical Conference on the Application of Ultrasonics in Welding." Akusticheskii Zhurnal, Vol. 6 (January-March, 1960), pp. 138-139. (Translation: Soviet Physics-Acoustics, Vol. 6 (July-September, 1960, pp. 138-139)

Silin, L. L., V. A. Kuznetsov, and G. V. Sysolin, "The Ultrasonic Welding of Aluminum and Its Alloys." Svarochnoe Proizvodstvo, March, 1960, pp. 12-15. (Translation: Welding Production, March, 1960, pp. 19-25)

Silin, L. L., "A Scientific and Technical Conference on the Use of Ultrasonics in Welding Processes." Svarchnoe Proizvodstvo, (April, 1960), pp. 42-44. (Translation: Welding Production, April, 1960, pp. 60-62)

Garber, R. I., L. M. Polyakov, and G. N. Mali, "Ultrasonic Welding of Copper." Fizika Metallov i Metallovedeniye, Vol. 10 (October, 1960), pp. 590-596)

Makarov, L. O., "A Simple Technique of Ultrasonic Cold Welding." Akusticheskiy Zhurnal, Vol. 6 (October-December, 1960), pp. 507-508. (Translation: Soviet Physics-Acoustics, Vol. 6 (October-December, 1960), pp. 507-508)

Silin, L. L., V. A. Kuznetsov, and M. A. El'yashev, "The Joint Strength of Ultrasonic Welds in Aluminum Alloys." Svarochnoe Proizvodstvo, Vol. 7 (July, 1960), pp. 5-8. (Translation: Welding Production, July, 1960, pp. 8-14)

Silin, L. L., V. A. Kuznetsov, and M. A. El'yashev, "The Joint Strength of Ultrasonic Welds in Aluminum Alloys." Svarochnoe Proizvodstvo, July, 1960, pp. 5-8. (Translation: Welding Production, July, 1960, pp. 8-14)

Ol'shanskiy, N. A. and A. V. Mordvintseva, "Ultrasound in Welding Technique." Industrial Use of Ultrasound, Gosudarstvennoye Nauchno-Tekhnicheskoye Izdatel'stvo Mashinostroitel'noy Literatury, Moscow, 1959, pp. 287-302. (Translation: Technical Documents Liaison Office, Translation MCL-810/1+2, MCLTD, Wright-Patterson AFB, Ohio, April 26, 1961)

Balandin, G. F. and L. L. Silin, "On The Role of Friction When Welding With Ultrasound." Izvestiya Akademii Nauk SSSR, Otdeleniye Teknicheskikh Nauk, Metallurgiya i Toplivo, No. 6, Moscow, 1960, pp. 42-46. (Translation Technical Documents Liaison Office, Translation MCL-1045/1, MCLTD, Wright-Patterson AFB, Ohio, June 26, 1961.)

Explorer Finds Many Particle Belts

by William Beller

THE EARTH is now believed to be girded by a pulsing and sharply bounded toroid of energetic particles distributed into many belts.

This new conception of "near space" comes from NASA's *Explorer XII* Energetic Particles Satellite, launched last Aug. 15 on a highly elliptical earth orbit.

Until the satellite stopped working on Dec. 6, it effectively transmitted data 80% of the time it was in orbit. Although less than 10% of the data have been analyzed, investigators see a new but somewhat confused picture emerging.

• **Belts dropped**—The earth's magnetic field is reported to terminate sharply at about 10 earth radii (measured from the earth's center). Why this happens is uncertain.

From 10 to about 13 radii there is said to be a thick turbulent or transition region marked by lack of a steady-state solar stream of particles. This region might even extend to 14 or 15 earth radii before interplanetary space begins.

The outer boundary of the magnetosphere—the term being given to the region of particles trapped by the geomagnetic field—"breathes" in and out between 8.5 and 12 earth radii. Dr. Frank McDonald, project scientist at Goddard Space Flight Center, suggested "(it) is caused by the impact of solar wind, which would in essence carry a field. . . ."

The older concept of an "inner" and "outer" belt of high-energy particles in the magnetosphere is being dropped. There are too many regions of constituents and intensities to consider.

"You can only say that in one particular region, one population (with) one type of energy reaches its maximum," Leo R. Davis, head of Goddard's energetic particles section, explained at a recent press conference. "At another location, another group reaches a maximum intensity, and so on."

Dr. Brian O'Brien, assistant professor and cosmic-ray experimenter at the State University of Iowa, said more graphically, "What we (have) is one big mess out there."

Still, some regions are taking shape, even though their boundaries seem to have been formed by a nervous kaleidoscope:

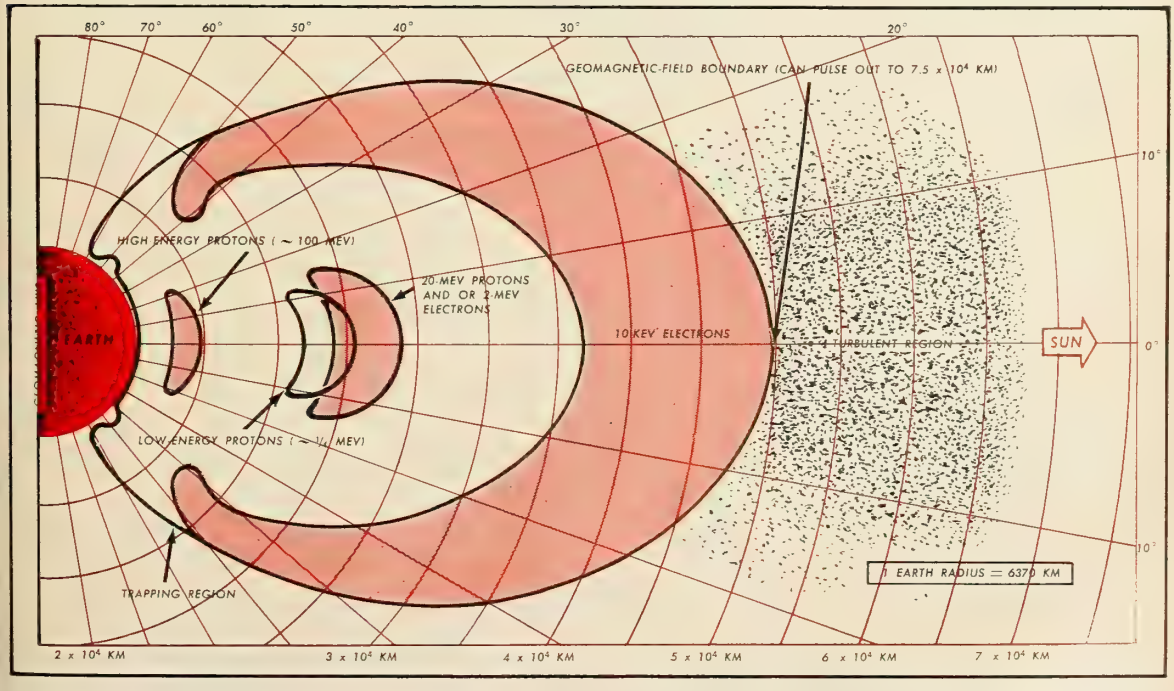
—At about 1½ earth radii, there is a pattern of high-energy protons in the 100-MEV range.

—At about three earth radii, there is a grouping of low-energy protons in the ¼-MEV range.

—At four earth radii, which was the center of the "outer belt," there are either protons in the 20-MEV range or electrons in the 2-MEV range, or perhaps both.

—Starting at about six earth radii and going out to the far edge of the magnetosphere are soft electrons with energies of 10 KEV.

(Continued on page 39)


80° 70° 60° 50° 40° 30° 20°
GEOMAGNETIC-FIELD BOUNDARY (CAN PULSE OUT TO 7.5 x 10⁴ KM)
HIGH ENERGY PROTONS (~ 100 MEV)
20 MEV PROTONS AND OR 2 MEV ELECTRONS
10 KEV ELECTRONS
TURBULENT REGION
SUN
EARTH
LOW ENERGY PROTONS (~ ¼ MEV)
TRAPPING REGION
1 EARTH RADIUS = 6370 KM
10°
0°
10°
2 x 10⁴ KM
3 x 10⁴ KM
4 x 10⁴ KM
5 x 10⁴ KM
6 x 10⁴ KM
7 x 10⁴ KM

FIRST DRAWING of the new concept of "inner space," based on data from Explorer XII satellite. The idea of having only two clearly defined belts of energetic particles trapped in the magnetosphere is being discarded in favor of many belts.

Ranger To Provide Real Moon Close-up

NASA expects pictures showing objects as small as 12 ft. wide; three other experiments aboard

by Charles D. LaFond

A SUCCESSFUL RANGER shot will enable man to view the moon's boulders with the same ease that he now inspects its mountain ranges.

The television camera and telescope subsystem to be carried in *Ranger III, IV* and *V* will provide over 100 pictures of the moon from altitudes varying from 2500 to 15 miles above its pocked surface. Employing a 200-line raster, the system should have such high resolution that objects as small as 12 feet in diameter can be distinguished, according to scientists of the National Aeronautics and Space Administration.

Prime contractor for the program is the California Institute of Technology Jet Propulsion Laboratory in Pasadena. Contracts to date for *Ranger III* alone amount to over $13 million and involve 28 major subcontractors.

Ranger III is an exceptionally complex space test facility — physically it looks like something that fell off a Rube Goldberg flying machine.

To assure success, three identical spacecraft have been built. Each will carry out four studies to obtain radar reflectivity characteristics, surface photographs, gamma-ray measurements, and seismic measurements.

The mission will terminate with the hard landing on the moon of an instrumental package designed to continue physical measurements for 30 days.

• **Close look at the moon**—One of the most exciting aspects of a successful *Ranger* mission will be the television projection of lunar surface detail. For the first time it will be possible to view the moon without the filtering effects of the earth's atmosphere.

Photographs of these transmissions will provide information needed to help select possible landing sites for future manned lunar landings.

Ranger could provide pictures having a resolution of 12 ft. (under optimum conditions), scientists believe. The best available photos today offer a resolution of about 1 kilometer.

The vidicon camera system will operate from about 2500 down to 15 miles above the lunar surface. Telemetered pictures will be comprised of 200 lines, built up over a 10-sec. period. Following this, another 3 sec. will be required to clear the screen for the next image.

During the 3-sec. interval, gamma-ray measurements and radar ranging data will be received from the spacecraft.

At the transmission rate of 1 picture/13 sec., over 100 pictures can be obtained.

Built for JPL by Radio Corporation of America, the electronics for the vidicon system are compressed into a 7-in.-dia. x 3-in.-deep disc. JPL developed a 14-in.-long telescope to complement the system. The optics provide the equivalent to a 40-in. focal length instrument, developers say.

• **Other experiments** — Successful measurement of characteristic gamma rays emitted from the lunar surface are expected to aid scientists in determining its composition. Also, heat production by a body such as the moon is determined to a large extent by its radioactive content. Gamma-ray spectrum analysis may help determine both.

This approach, according to JPL, has a great advantage over ordinary chemical analysis to determine surface composition in that it provides a measurement of average composition of a large area, rather than a specific breakdown of a small sample which may not be truly representative.

One other advantage is that relatively delicate instruments need not actually land on the moon to obtain meaningful data.

Radar reflectivity studies of the lunar surface in the impact areas will be made using the *Ranger's* radar altimeter. The radar system will illuminate an area of up to 60 square miles.

Results may be used to establish a standard area for the calibration of more complex radar used on earth for lunar observations.

Operating at 9.400 gigacycles, the magnetron has a peak power output of from 150-400 watts. Operation is standard pulse-type. Radar pulse width is 2 microsec., repetition rate is from 500 to 600 pulse/sec.

Seismic measurements performed by instrumentation in the lunar-landing capsule are expected to provide data concerning the thermal history of the moon and the structural processes currently taking place.

Both quakes and meteorite impacts could generate body waves whose measurements will tend to indicate the physical state of the lunar core. The kinds of waves recorded will help describe the lunar surface.

The seismometer to be used, while extremely sensitive, is rugged enough to withstand a 200-mph impact on solid granite. Its cylindrical package measures 5.27-in.-long x 4.37 in.-in-diameter. Weighing only slightly more than 8 lbs., the single-axis unit was designed and built by the California Institute of Technology's Seismological Lab and the Lamont Geophysical Observatory, Columbia University.

The seismometer, its amplifier, battery supply, and a 50-milliwatt transmitter are housed within a 12-in.-dia. metal sphere. The sphere floats in oil within an outer impact-absorbing balsa wood shell.

The transmitter is energized automatically during launch. Caging pins hold the instrument sphere rigidly during flight and are released during the terminal landing maneuver.

After landing, the sphere rights itself automatically and the transmitting antenna points to earth. Next, two pyrotechnic slugs are flown out of the assembly to vent the oil (otherwise the heavy liquid might act as an insulator between the seismometer and the tremors to be measured).

Temperature stabilization within the sphere will be achieved by the inclusion of a sealed water container. Thus, the operating temperature within the package will always stay within the boiling and freezing points of water under lunar conditions.

• **Control sequence**—Until separation of *Ranger III* from the *Agena-B*, guidance and control will be provided

by the *Agena* system.

Following separation, spacecraft control will be directed from the deep-space tracking center at Goldstone, Calif. Direct control is implemented by a Central Computer and Sequence located in one of six packages joined to form the hexagonal base of the main craft. This solid-state, digital CC&S controls most of the spacecraft maneuvers and experimental functions until separation of the lunar capsule from the main spacecraft.

Control sequence for the remainder of the 66-hour trip is planned approximately as follows:

At T + 30 min. (T equals earth launch time), the two spring-loaded solar panels will be released from the launch, or folded, position to the cruise position. Also, the 4-ft.-dia., high-gain antenna will be swung out on its hinge from the aft end of the craft to an extended preset position.

At T + 33 min., an inertial attitude-control system will be activated. Solar sensors (four on the hexagon sides and one on each solar panel) will seek out and lock on the sun. Maneuvers will be effected by 10 cold-gas reaction jets.

At T + 3.5 hrs., the gear-driven high-gain antenna will search for, locate and lock on the earth without affecting the already established solar orientation. A three-section photomultiplier tube-operated earth sensor, mounted coaxially with the antenna, will be used as the seeker. (If the sensor accidentally locks on the moon, the situation will be recognized through the telemetry data received at ground control. Goldstone could then send an override command to the *Ranger* attitude control system for repositioning. This could be accomplished at about T + 12.5 hours.)

At T + 4 hrs., the initial gamma-ray experiment will be activated. The spectrometer is located in a 12-in.-dia. aluminum sphere mounted on a 40-in.-long boom extending outward from the top of the hexagon base.

For the next few hours, the greatest activity will occur at DSIF (the Deep Space Instrumentation Facility). Worldwide tracking data from its three large radar sites will be fed into the IBM-7090 at Jet Propulsion Laboratory, Pasadena, Calif.

After calculating vital direction and amount of pitch correction, direction and amount of roll correction, and velocity correction, the results will be telemetered to the CC&S for storage and checked for correct subsystem address.

At T + 16 hrs., Goldstone will send the command to start mid-course correction. Maneuvers will begin after switching from the directional antenna to the omni antenna and repositioning, temporarily, the dish out of the path of the midcourse-motor exhaust.

After maneuvering *Ranger* into the correct lunar collision course, the CC&S will again initiate commands to effect sun and earth reacquisition maneuvers.

At T + 18.5 hrs, the CC&S will switch back to use of the high-gain dish antenna. Also, pressurized gas will be released to extend the gamma-ray spectrometer boom to its full 72-in. limit. This is expected to help avoid measurement of secondary effects caused by cosmic rays interacting with the main body of the spacecraft.

For the next 48 hours, gamma-ray experiment reports will be made every eight min.

DSIF will continue its tracking and data will be continually fed into the 7090 for computation of expected lunar impact time. When an accurate estimate is available, *Ranger* position 65 min. before impact will be determined for use in effecting the terminal maneuvers.

At impact −95 min., terminal maneuver commands will be sent by Goldstone to the CC&S for storage, and again the system will be checked for correct receipt.

At impact −65 min. (5000 miles altitude), the go command will be given. The spacecraft will be turned to aim the television camera directly at the lunar surface. (Since the solar panels will be disoriented following the maneuver, a 25-lb. silver-zinc backup battery will provide power up to capsule separation just before impact.) The TV camera will be turned on for warm-up.

After completing the terminal pitch maneuver, CC&S will initiate a 2-min. time delay command to move back the arm holding the omni antenna in place atop the capsule. This will clear the path for separation of the lunar capsule from the main platform.

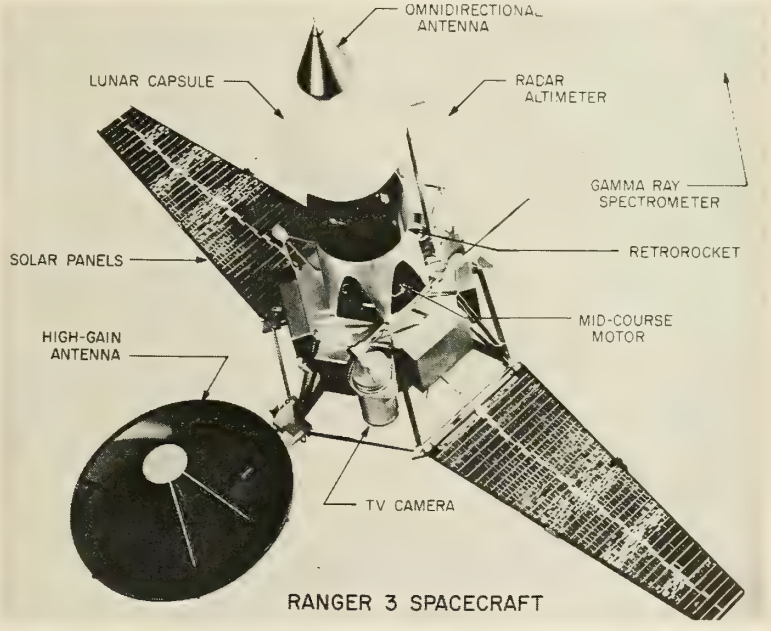
The spring-loaded radar altimeter will then extend outward and begin transmitting pulses to the lunar surface. At the same time the TV camera cover will be moved to clear the telescopic lens.

At impact −40 min. (2400 miles altitude), the camera will begin operation, transmitting one picture every 13 sec. Gamma-ray telemetry will be shifted to a higher transmission rate (a report every 52 sec. instead of every 8 min.).

At impact −8.1 sec. (70,200 ft.), the radar altimeter will initiate the capsule separation sequence. Control and sequencing at this point will be switched over to a unit in the capsule assembly. (See M/R, Jan. 22, p. 18 for details of terminal sequencing and capsule impact.)

Capsule separation from the main craft at 52,000 ft. is expected to disorient the high-gain antenna in relation with earth. Thus, TV transmissions from then until final catastrophic impact will be lost.

The retro motor will reduce the instrumentation capsule assembly to zero velocity at 1100-ft. altitude. Separation of the landing capsule and the motor assembly will be initiated by the sequences and the 96-lb. balsa wood-encapsulated package will free-fall to the moon's surface. Impact should occur at less than 150 miles/hr. ⌘



NASA PHOTO of scale model of 10.25-ft.-long, 17-ft.-span Ranger III spacecraft.

Lear Mass-Produces Microcircuits

by Arthur H. Collins

A NEW TECHNIQUE for mass-producing microcircuitry may cut circuit costs by 10-50% while increasing reliability by a factor of 10.

The semiautomatic, high-vacuum deposition system was developed by Lear, Inc., of Santa Monica, Calif. Albert G. Handschuhmacher, Lear president, says:

"Development of the technique means that we can produce up to 500 tailor-made. thin-film microcircuits in a single two-hour vacuum cycle, depending upon circuit complexity. Any electronic circuit can be microminiaturized, and delivery of the finished product started within six weeks."

Developed by Lear's solid-state physics laboratory, the production machine will deposit any one of three different materials representing resistors, capacitors, magnetic or semiconductor elements.

The production system consists basically of a vacuum chamber, high-voltage power supplies for evaporation of the resistor, dielectric materials, vacuum pumps to reduce chamber pressure to $1x10^{-6}$ mm of mercury, a digital ohmmeter and an optics system to monitor materials deposition, plus a mechanical connection to the chamber for changing of masks and substrates.

Deposition is made through five different masks or patterns onto substrates placed in 20 one-in.-square holders. The number of substrates (glass plates or other materials) handled by the machine is dependent upon the size of the plates in the 20 holders. This number may be increased to the suggested 500-circuit maximum capability of the machine, and is limited only by size of the circuits themselves.

The machine deposits complete resistor and capacitor patterns well within individual component tolerances of 5%. One percent tolerances are reasonable if hand adjustments are made instead of automatic operation of resistance deposition. All resistors needed for a complete circuit can be deposited in 15 sec., with 5% tolerances.

The resistance factor is inversely proportional to time—consequently the 15-sec. time limit is more than adequate for deposition of resistors regardless of their number. The same deposition time is required by the microcircuit condensor patterns.

• **Production steps**—1. *Circuit design and bread board test:* The initial phase of integrated microcircuit design is the same as that of any conventional circuit. Performance parameters are selected; the required circuit elements are computed, then evaluated on an engineering bread board circuit layout.

2. *Circuit schematic prepared:* Practically any functional electronic circuit can be microcircuitized by the process, offering greater flexibility to circuit functions. Preparation of the circuit schematic is similar to that for welded or etched circuitry.

3. *Rough microcircuit layout:* This is the first deviation from standard production procedures, and is a most important process from the standpoint of size reduction of the final product—the rough layout dictates final circuit size.

4. *Precise mask artwork:* When microcircuitry design and layout is complete, the first mechanical step follows—preparing the precise stencil-type masks or patterns. The importance of accurate masking techniques to the fabrication of accurate microcircuitry cannot be overemphasized. Through use of precision techniques, post-evaporative hand tailoring or adjustment is essentially eliminated.

5. *Carefully controlled photographic size reduction of art:* Here again, the finished product is only as good as the mask allows for reproduction.

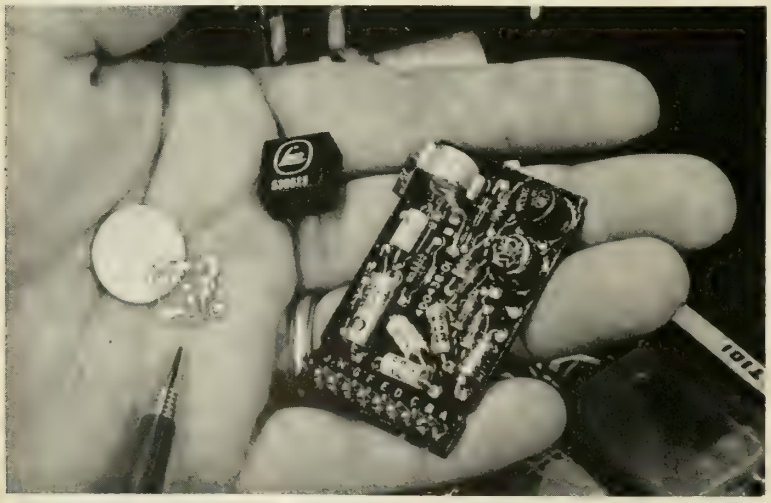
6. *Mask preparation:* One set of masks is prepared for each type of circuit. Small etching machines with oscillating spray nozzles are used to etch the precise evaporation masks.

The masks are generally nickel or stainless steel. It usually takes from four to five hours to produce one.

This is another area in which cost reductions have been made. A year ago, a typical mask cost about $5000 to produce. Today, the same mask costs around $1500, and Lear predicts a production goal of $500 by mid-1962.

As mask costs come down, the need for standardization of circuits is minimized because virtually the same costs are involved for either new design or standardization of an old design.

7. *Circuit vaporization:* Electronic components of the Lear system are fabricated from thin-film materials. The equipment can evaporate thin films of resistive, conductive, magnetic and



CUSTOM-MADE thin-film microcircuits (at pencil point) can now be mass-produced by Lear, Inc.'s newly developed high-vacuum deposition system.

semiconducting materials. From combinations of these materials, any desired form of integrated microcircuitry can be produced. Nickel-chrome alloy wire is fed into the evaporator as resistor material. Silicon monoxide is used for deposition of dielectric material, with soft glass as the substrate material except in special applications.

8. *Test and evaluation:* Testing and evaluation of the circuits is performed during the deposition phase. Resistance is checked by sampling a test strip deposited concurrently with the circuit deposition, and capacitance is checked and controlled through optical analysis of the electrolyte as it is deposited.

9. *Encapsulation:* Conventional techniques of circuit encapsulation are used, depending upon customer requirements.

10. *Delivery of finished product:* The time required for the design, development and fabrication of a typical circuit is estimated by Lear to be from five to six weeks.

Lear has proposed a license/lease agreement to enable "select" electronic manufacturers to use the company's process. The agreement would cover the equipment, training and service program. Financial arrangements would include payment of an initial license fee plus a royalty based on microcircuit production. ⌗

GE's Advent Tubes To Last 3 Years Through Use of 499 Nickel, Exhaust Method

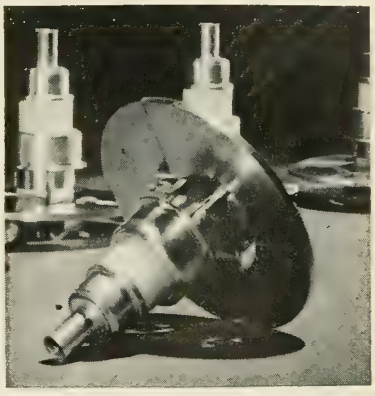
"LIGHTHOUSE" tubes are being built to a three-year operation specification for the Army's *Advent* communication satellite.

The planar triodes for the satellite's multi-channel transponders are being produced under extremely rigid manufacturing procedures at General Electric's Receiving Tube Department in Owensboro, Ky., to assure reliability.

Each one of the custom-built electron tubes is operated for at least 1000 hrs. before being shipped, the company says, to enable engineers to predict whether it will last for three years. This is one of the most important aspects of the department's $837,000 development contract.

A distinctive feature of the tube, giving it a lighthouse shape, is its heat sink. This is a ring of oxygen-free high-conductivity copper to act as a thermal conductor in space.

GE says the life expectancy of the tube is greatly increased by the use of 499 nickel in the cathodes, permitting a relatively low rate of plate dissipation. Moreover, the company has devised vacuum exhaust equipment to produce



COPPER heat sink gives planar triode for Advent ComSat "lighthouse look." Tube is built to last 25,000 hrs. in space.

"consistent" levels of 5 x 10^{-9}mm in the tubes at seal-off.

Advent, scheduled for first launch later this year, is planned to consist ultimately of three satellites in widely-spaced, synchronous, 22,300-mi. orbits. The system would thus cover about 80% of the earth's surface at all times. ⌗

EXPLOSIVE ORDNANCE

to ignite to detonate to actuate to eject to open to close to pull to push to stabilize

NO ORDINARY SQUIB, THIS ONE...

The stainless steel M-100 is designed for space travel (qualified for Titan II) — is at home in a variety of environments — and unlike most pressure cartridges, can do a myriad of "jobs." The M-100's versatility is in its ability to sustain pressure for relatively long periods (see below). Its extreme environmental capabilities are the result of resistance welding the closure to the shell providing an hermetic seal plus no fragmentation of the closure. A few of the M-100's characteristics:

safety — *1 amp no-fire and 2-amp sure-fire per bridge wire* **reliability** — *99.9% and 90% confidence* **functioning time** — *2000 psi in 5 milliseconds (in a 10 cc chamber) — sustains 1000 psi for 1 second* **environmental** — *200,000' altitudes, 100 g shock, random and Sine vibration in excess of MIL-E-5272, temperatures of — 100 to + 200°F.*

For complete specifications on the all-purpose M-100 and other McCormick-Selph advanced explosive ordnance devices — write stating requirements to address listed below.

McCORMICK SELPH

Hollister Airport/Hollister, California/ Dept. M

Circle No. 9 on Subscriber Service Card

No hold-up seen . . .

Polaris A3 Fiber Glass Case Being Developed Rapidly

SUNNYVALE, CALIF.—A lightweight, high-tensile-strength fiber glass casing—a major factor in the accelerated effort to extend the range of the Navy's *Polaris*—is being developed rapidly and should not hold up the overall development program.

The push to produce *Polaris A3*, with a range of 2500 miles, has resulted during the past six months in a 30% gain in the operating stress level of glass fiber motor casings.

This progress and other state-of-the-art advances in glass filament-wound motor structures were reported here this month at the second *Polaris* missile system contractor symposium.

Nearly 100 representatives of industry, the military and universities participating in the *Polaris* fiber glass casing program attended the two-day classified meeting at Lockheed Missiles & Space Co. A similar reporting sessions was held six months ago.

Steel was used for both stages of the 1200-mile range *Polaris A1* now deployed aboard the six operational Fleet Ballistic Missile submarines. The 1500-mile *Polaris A2*, now entering production, is a hybrid, with a steel first stage and fiber glass second stage.

Both stages of the *A3* will use filament-wound cases. The two principal advantages of glass over steel are a substantial weight reduction and a 66% slash in cost.

The *A3* is scheduled for operation in early 1964. Besides the lightweight casings, factors in the *A3* program are development of a hotter propellant, with a major increase in specific impulse, and reduction of component weight through miniaturization. The *A3* range extension is to be achieved within the same dimensions as the *A2* missile—31 ft. long and 54 in. wide.

• **Other advances** — Twenty-five papers were presented and six panel discussions held at the symposium. State-of-the-art improvements were reported in:

—Overall structural efficiency of glass fiber casings.

—Development of optimized winding patterns.

—Improved inspection techniques.

—Motor case port reinforcement techniques.

—Optimized hydrotest techniques.

—Applied stress analysis.

Considerable emphasis in the *Polaris* program has been directed at learning why glass thread loses 50% of its tensile strength between the time it is spun and when it is used within the missile casing.

Although this problem is still unsolved, participants reported they are getting a better understanding of the crazing of filaments and other degrading factors due to environmental usage —chiefly debonded areas and knots in the casings.

Lockheed MSC research indicates that infrared techniques may be promising for inspection to detect flaws in the structures.

Agencies represented at the meeting were the Naval Special Projects Office, Aerojet-General Corp., Allegany Ballistics Laboratory, General Electric Co., Narmco Industries, University of Vermont, University of Illinois, Naval Research Laboratory, Westinghouse Electric Corp., Hercules Powder Co. (Rocky Hill), Rocketdyne, Bendix Corp., B. F. Goodrich Corp. and Kidde Aerospace Div. ⁂

18-Orbit Shot Slips

(Continued from page 18)

The number of bays built for each stage will depend on the firing rate which the space agency expects to need at the complex. It is expected that six or eight bays will be built. This will support a firing rate of 25 to 30 launches per year.

NASA also has some $70 million in the Fiscal '63 budget for the launch complex for the *Nova* vehicle.

NASA officials report that most of the funds will be used for design and study contracts for the three-pad facility. No hardware or construction contracts on the *Nova* site will be awarded until Fiscal 1964.

Each *Nova* pad will be capable of eight launches per year. Each gantry will be 450 ft. high and 20 ft. square at the base. The vehicle will be assembled and checked out on pad. Because of the gantry's immense size, it will be immovable; the booster will have to be fired through it. The gantry's sides will be lowered to allow exhaust gases to escape.

The vehicle will be moved from its manufacturing plant to the launch site on large barges, which will also serve as the launch pad. ⁂

New Solid-State Laser Described by Bell Labs

NEW YORK—The first known solid-state—ruby—optical maser to emit continuous coherent visible light was described by Bell Telephone Laboratories here last week.

The disclosure was a highlight of the 10th Annual Physics Show, sponsored by the American Physical Society and the American Association of Physics Teachers, which drew an estimated 4000 persons.

D. F. Nelson and W. S. Boyle, Bell scientists who developed the maser and presented the post-deadline paper to the meeting, said the advance was made possible by a new method of exciting the master crystal which gives a pumping intensity five times greater than any previous technique.

A major improvement in the solid-state maser was the significant reduction in power requirements for continuous operation. Ruby originally required more than 1000 kilowatts for pulsed operation; the new Bell maser is reported to need a minimum input of 850 watts for continuous operation.

Output power in the maser beam is described as "a few milliwatts."

Transfer of the intense light from a high-pressure mercury arc lamp to the crystal face is accomplished by two concave spherical mirrors. The ruby crystal is located inside a Dewar kept at liquid nitrogen temperatures.

The maser material consists of two separate materials grown as a special boule of one crystal. The actual crystal is shaped like a trumpet. Its "front" is pure aluminum oxide—sapphire—in the shape of a cone forming the "bell" of the trumpet. The face of the bell, about 60-mils.-dia., receives the pumping arc. The cone portion tapers to meet a shank of chromium-doped aluminum oxide, or ruby, which has a 24-mils. dia. In this shank the maser action takes place, producing the intense red maser beam.

The image of the arc of the pumping lamp reaches the face of the trumpet at the same size and intensity as the arc itself. The cone acts as a "radiation condenser," making the arc light six times more intense as it enters the shank. The light then travels down the shank by internal reflections.

A silver coating at the end of the rod causes the pumping light to return and emerge at the original face. Since the pumping light travels a double path, its intensity, already increased six times, is doubled, making it much greater than that in a conventional maser rod receiving light from the side. The result, Bell says, is a lower required power for the pumping lamp that produces the continuous maser action. ⁂

Rendezvous vs. Direct Debated at IAS Meeting

by Michael Getler

NEW YORK — The still-uncharted U.S. route to the moon was debated by top lunar experts at last week's 30th annual meeting of the Institute of Aerospace Sciences.

Supporters of orbital rendezvous tangled anew with direct-flight proponents, the former presenting more papers.

A NASA study of rendezvous techniques showed that visual control is a better bet than instrument-controlled approach.

A pilot, the study said, can control a terminal rendezvous without instruments for range, space angles, and time derivatives for these parameters, if he has sufficient background reference to make angular measurements on the order of 1 milliradian. This reference can be supplied by a single high-angular resolution instrument for obtaining line-of-sight rate, and a timer which can be read to within 0.1 sec.

• **Lunar landing**—Results in NASA's study of simulated soft lunar landings showed that pilots flying the fixed-base flight simulator at Langley Research Center could establish proper lunar orbits and, with more difficulty, effect satisfactory landing.

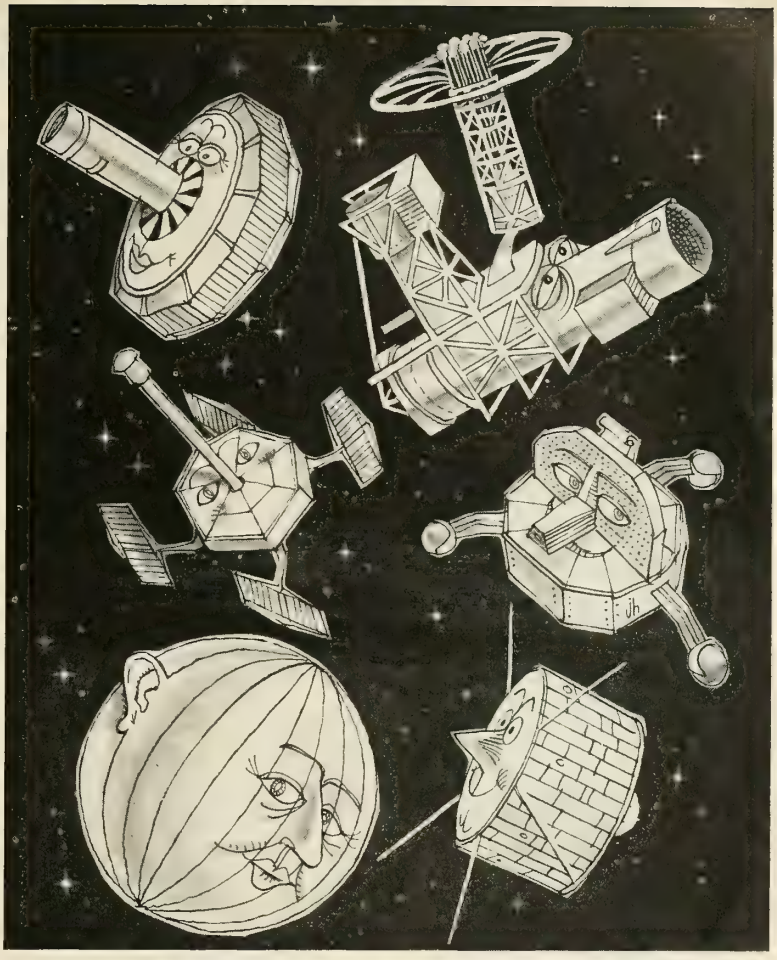
Early single-pilot flights produced a marked caution and resultant erratic flight path as the vehicle approached within 400 ft. of the lunar surface. The craft often hovered, even climbed, and in many cases overshot the marked landing area due to extreme pilot concentration.

The addition of a second pilot to split attitude and thrust control functions resulted in an effective landing mode which generally produced landings with velocity components of less than 4 FPS and within a 2000-ft. radius of the desired landing site.

Continued practice in the landing technique eventually led to satisfactory one-man operation of the simulator.

• **24-day moon journey**—A direct flight to the moon and back, lasting about 24 days and using an orbit launch method for a high-performance nuclear hydrogen rocket, was outlined by two scientists from United Technology Corp. and Space Technology Laboratories.

The mission begins in a 300-mile earth orbit with velocity sufficient for the nuclear propulsion system to maintain. Pulsed low thrust is applied at the perigee until the apogee reaches the moon's orbit. This is followed by rocket braking to the surface. Return trip is similar, but with a stable 50-mi. orbit established about the moon. ⌘

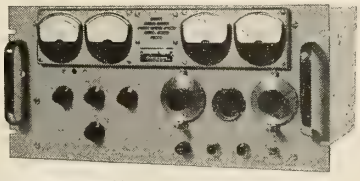


Six Different Languages... NEMS-CLARKE® 1440 Receiver Interprets Them All!

This hard-working navigational telemetry receiver is already monitoring Transit, Traac, Echo, S3, S16, Stratoscope. It is an exceptionally stable Phase-Lock Receiver with a tuning range of 130-140 mc. The 1440 is particularly suited for the forthcoming S-27 Orbiting Astronomical Observatory.

Nems-Clarke 1440 provides outputs for video, spectrum display, frequency monitor and signal strength recorder. Its four panel mounted meters indicate tuning, output, deviation and signal strength during operation. The receiver is for standard rack mounting.

Write for Data Sheet C-006, Vitro Electronics, 919 Jesup-Blair Drive, Silver Spring, Maryland. A Division of Vitro Corporation of America.



Vitro ELECTRONICS

Specifications:

1. Type of Reception....FM
2. Tuning Range....130-140 mc
3. Noise Figure....6 db maximum
4. IF Bandwidth —
   Wide Band ....100 kc at 3 db points
   Narrow Band .... 50 kc at 3 db points
5. Phase-Lock Detector....linear to better than 1% over bandwidth of ± 50 kc
6. Video Output ....adjustable
7. Video Frequency Response....400 cps to 15 kc
8. Sensitivity....0.3 v peak to peak per kc of deviation, minimum

Questions and Answers about the

GLOBAL COMMUNICATIONS CAPABILITIES of RCA

What capabilities? From which subsidiary of RCA?

From RCA Communications, Inc.

Uncommon capabilities for designing and operating **ground communications networks of world-wide scope** needed by contractors, sub-contractors, and government agencies engaged in **space or missile projects.**

RCA Communications also provides facilities for private communications . . . data communications . . . and commercial communications of all kinds — telegraph, telex, radiophoto, and radiotelephone by means of radio and coaxial cable channels. It designs not only completely new systems but also systems incorporating the most efficient and economical arrangement of established facilities.

How were these capabilities acquired?

Through 41 years experience in building and operating a world-wide communications system. Today, RCA's integrated telegraph, telex, and radiophoto networks reach more than 100 countries and ships at sea.

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GATES

LIDDEL

John Stack and Maurice Roy: Elected to Honorary Fellowship by the Institute of the Aerospace Sciences. This is the highest honor bestowed by the IAS, Free World professional society in the aerospace field. Stack is director of Aeronautical Research in the NASA Office of Advanced Research Technology, and Roy is Director General of the Office National d'Études et de Recherches Aeronautiques, France's Aerospace Research and Development Center. Other awards presented at the IAS Honors Night Dinner on Jan. 23 were to **Dr. Alfred J. Eggers, Jr.,** Chief of NASA's Ames Research Center Vehicle Environment Division, who received the Sylvanus Albert Reed Award; **Capt. Ashton Graybiel,** Director of Research, Navy School of Aviation Medicine, Pensacola, Fla., who received the John Jeffries Award; and recipients of IAS Fellowships: **Holt Ashley,** Department of Aeronautics and Astronautics, Massachusetts Institute of Technology; **J. A. J. Bennett,** Head of Department of Aerodynamics, College of Aeronautics, Cranfield, England; **H. G. Conway,** Director, Short Brother & Harland Ltd., Northern Ireland; **John C. Evvard,** Deputy, Associate Director for Research, Lewis Research Center, NASA; **Paul Germain,** Professor of Mechanics and Fluids, University of Paris, France; **S. K. Hoffman,** President, Rocketdyne Division, North American Aviation, Inc.; **W. H. Pickering,** Director, Jet Propulsion Laboratory, California Institute of Technology; **Harrison A. Storms, Jr.,** President, Space and Information Systems Division, North American Aviation Inc.; **Charles R. Strang,** Transport Aircraft Engineering, Douglas Aircraft Co., Inc.; **Itiro Tani,** Aeronautical Research Institute, University of Tokyo, Japan; and **Alfred V. Verville,** Bureau of Naval Weapons, Department of the Navy.

William F. Foss: Senior vice president for Finance and International Operations and Treasurer of Motec Industries Inc., Hopkins, Minn., succeeds **Edmund F. Buryan** as president, chief executive officer and a director.

Robert J. Swain: Former division manager of the United GeoMeasurements Division of United ElectroDynamics, Inc., has been promoted to vice president in charge of the division.

Jonathan J. Broome: One of the members of the founding group of SCOPE Incorporated, Falls Church, Va., has been appointed vice president in charge of production.

Frank J. Kiernan: Has joined General Precision, Inc., Tarrytown, N.Y., as director of market research.

William F. Gates: Associated with Dalmo Victor Company, a division of Textron Inc., since 1944, has been named president, succeeding **T. I. Moseley.**

Dr. Urner Liddel: As assistant director of Hughes Aircraft Company's Research Laboratories, Culver City, Calif., will be responsible for technical liaison with academic institutions in addition to adminstrative duties.

Harrison Edwards, Alex Hossack and George Liacouras: Will fill three newly created positions in Simmonds Precision Products, Inc., Edwards as vice president-manufacturing, Hossack as vice president-engineering and Liacouras, as vice president-finance.

Burton P. Brown: Leaves General Electric to assume a new position as assistant director of Defense Research and Engineering for Air Defense with the Department of Defense.

Paul W. Atwood: Former president of U.B.S. Chemical Corp., Cambridge, Mass., selected as chairman, Executive Committee of Trans-Sonics, Inc., Lexington, Mass.

James C. Smith, Jr.: To be located at the Marshall Space Flight Center's Michoud Operations plant in New Orleans, as president of the newly organized Space Division in Chrysler Corporation's Defense and Space Group.

Joseph M. Hertzberg: Rejoined the Radio Corporation of America as division vice president, Defense Marketing. In his new position, Hertzberg will direct all marketing activities within the RCA Defense Electronics Products organization, including supervision of product planning, marketing administration, defense and public affairs activities, and supervision of the operation of a broadly expanded network of field offices across the country. Hertzberg first joined RCA in 1945, left to become vice president of marketing of Philco Corporation's Government and Industrial Group in 1960.

Circle No. 11 on Subscriber Service Card

New Light on DOD Budget

(Continued from page 17)

the development of greatly improved radars, other sensory devices and computers, as well as the operation of the system."

Hawk—"The *Hawk* procurement (in FY '63) will closely approach the deployment objective."

Redeye—"Tentatively, the *Redeye* will be placed in production with initial procurement of missiles in FY '62. Another increment is included in the FY '63 budget."

Sparrow III and Sidewinder 1C—Funds are sought for "substantial quantities."

Talos, Terrier and Tartar—Funds are sought for "substantial quantities."

Tactical Missiles

Davy Crockett—The budget requests $12.6 million for procurement that is expected "to provide a large part of our inventory objective." (First sizeable deployment of the nuclear-tipped battlefield missiles is planned this year.)

Pershing—"A quantity of Pershings are also included in the FY '63 budget."

Sergeant—"The 1963 procurement of *Sergeant* missiles, together with those funded in prior years, will completely meet the inventory objective for the approved forces except for future requirements for training missiles." (No mention was made in the cleared statement of the possible procurement of *Sergeants* for NATO—long considered a strong possibility.)

Zuni 5—The budget requests funds for purchase of "substantial quantities."

Shrike—"The first buy of *Shrike* antiradar missiles is included."

Bullpup — "Substantial quantities" for the Navy; "substantial increases for the Air Force.

Subroc—The budget requests funds for "another quantity" of the underwater-to-underwater ASW missiles.

R&D/Military Astronautics

Defender — The budget requests $110 million for research aimed at providing the basis of advanced missile defense systems—the same total appropriated for the current fiscal year. "Emphasis will be placed on the development of measurement devices and measurement experiments looking toward the definition of a weapons system concept."

Vela—The budget requests $63 million for the various *Vela* nuclear-blast detection projects—$3 million more than Congress appropriated for *Vela* in FY '62. A number of *Atlas-Centaur* boosters will be used in the FY '63 program.

Propellant Chemistry—The budget requests $23 million—nearly a $5-million increase over FY '62.

Advanced ICBM—The study of advanced ICBM systems is to be funded.

Aerospace Plane—The budget requests funds for work on *ASP* components. This is a "prudent approach" aimed at solving "basic problems first . . . before we decide whether to begin the very expensive system development phase of this project."

X-15—The budget requests $10 million.

Titan III—"We visualize this Titan *III* standard launch vehicle as a work horse booster to place in orbit a broad range of payloads." This project includes a "standardized upper-stage vehicle" that will be compatible with *Titan III* as well as other primary boosters.

Solid Superbooster — Additional funds—reported to be about $40 million—are requested beyond the $50 million appropriated in FY '62 for development of a "very large solid rocket motor."

National Ranges—The budget requests a total of $445 million for AMR, White Sands and PMR—"almost 50 percent more than 1962." Most is for "increased ground instrumentation and instrumented ships" at the Atlantic Missile Range.

Dyna-Soar—"The level of effort we are recommending is all that is required and all that can be effectively utilized." McNamara did not reveal the amount. ⁂

New 'Belt' Concept

(Continued from page 31)

• **Mistake found**—A State University of Iowa experiment unexpectedly revealed what may be an error by a factor of a thousand in previous estimates of the electron intensity in the "outer" radiation zone. Past measurements were interpreted to indicate that the intensity of electrons with energies above 40 kilovolts was about 10^{11} particles/sq. cm./sec. However, *Explorer XII* data show that the actual intensity is closer to 10^{8} particles/sq. cm./sec. Some earlier "invalid assumptions" are blamed for the error.

Even though the electron intensity is shown to be lessened, there is no decrease in the radiation hazard for astronauts.

The 83-lb. *Explorer XII* satellite started out with a 182-mile perigee, a 48,000-mile apogee, and a 26.5-hour period. Later the orbit was distorted by solar and lunar perturbations which pulled the perigee upward.

Predictions are that the satellite will probably re-enter in two years. Meanwhile, it is still being monitored in the hope it will resume transmitting . ⁂

ROCKET ENGINE HANDLING?

Pneuma-Grip® solves problem of removing and inserting engines without damage to highly sensitive surfaces. Pneumatic rubber rings contact maximum area at minimum psi.

Unit shown was developed for the Saturn Rocket Program being conducted by the George C. Marshall Space Flight Center, Huntsville, Alabama.

For 16-page descriptive catalog write:

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Also manufacturers of Pneuma-Seal for critical sealing problems

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jpl needs

DEVELOPMENT ENGINEERS

COMBUSTION DEVICES

To be responsible for supervision of the design, fabrication, testing and evaluation of liquid rocket engines.

Experience in research, development and testing of rocket components, gas generators and associated equipment.

Must have degree in Mechanical, Aeronautical or Chemical Engineering. M. S. preferred.

LIQUID PROPULSION SYSTEMS

Will be responsible for developing and proving new concepts in liquid rocket systems for spacecraft application.

Experience and interest in propellants, liquid rocket engines, hydraulic and pneumatic circuitry, expulsion devices or components is required.

Must have BS or MS degree in Mechanical, Aeronautical or Chemical Engineering.

Submit complete resume to

H. M. MARXMILLER

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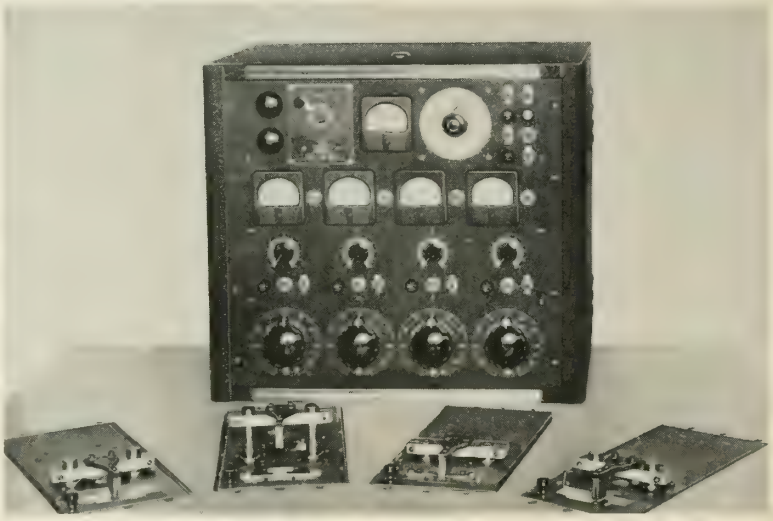


New Product of the Week:

Glass Diode Sealer

Research Instrument Co. has available in either a four-head or five-head version a universal diode sealer, which can make gold-bonded germanium diodes or Ohmic contact devices by means of controlled overtravel.

The operator loads a whisker assembly and a sleeve assembly into the machine and as the whisker approaches the germanium or silicon, it goes into a slow approach. At the moment of contact, a control circuit either stops the head or allows it to go through a controlled overtravel. The glass is then fused, sealing the unit.

The four-head sealer generally can produce more than 400 diodes per hour, with upwards of 500 per hour per operator for the five-head sealer.

Circle No. 225 on Subscriber Service Card

Pressure Switch

Servomechanisms, Inc., has available a pressure switch possessing extremely high accuracy and reliability. Designated SM/I Type TR 2129, the switch supplies a switch closure or opening on either an increasing or decreasing pressure.

The heart of the unit is a pressure transducer using a twisted Bourdon tube. This transducer has a long history of production for both missile and aircraft applications. By coupling it with unique solid-state circuitry, SM/I has produced a pressure switch with either single or multiple switch points.

In addition, the TR 2129 has the distinct advantage of a complete solid-state switching function, eliminating all the moving parts and contact closure points normally found in mechanical switches.

Circle No. 226 on Subscriber Service Card

Electrohydraulic Forming

A packaged electrohydraulic forming system available from the Westinghouse Electric Corp. can store up to 42,500 joules at 20,000 volts, be charged to full voltage in about three minutes, and discharge at the rate of 33 microseconds per cycle.

The system consists of a bank of low-inductance energy-storage capacitors, special switches for discharging this bank into the load, interconnecting

leads, a d-c power supply for charging the capacitors, and the required controls for operating the device. The system is packaged in two parts: a control console and a separate modular power unit, consisting of d-c power supply, capacitor bank, and switches. Additional modular power units can be added to the single-control system to increase system capacity, provide more reliability, or give longer life.

Circle No. 227 on Subscriber Service Card

Air Dehydrator

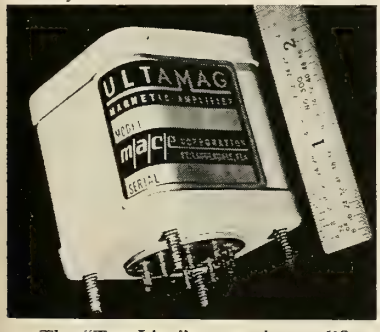
A compressed air dehydrator package for drying air and ridding it of oil and dirt contaminants is available from Wilkerson Corp.

Rated at a maximum of 10 scfm at 100 psi, the unit can lower the dew point of air to −100°F, and removal of oil to 2 PPM. It does not require draining: the first stage of the unit has a moisture separator with a built-in automatic sump drain mechanism. The second stage is a filter that removes dirt—as small as 3 microns in size—and oil fumes.

Circle No. 228 on Subscriber Service Card

Magnetic Amplifiers

A series of miniaturized magnetic amplifiers measuring less than 8 in.^{3} has been designed by Military & Computer Electronics Corp. Intensive lab testing and lack of field failures give the units a life conservatively estimated at 10 years.



The "Ten Line" magnetic amplifiers are d-c to d-c, operating in the 1 to 10 microwatt range with a power gain of approximately 40 db. Delivering + or −7.5v across lk ohm, the units will withstand 1000% overloads or operation into short circuit. Power requirements are 115v (+ or −10%) on a 400 cps source. Range of operating temperatures is from +10° to +130°F.

Circle No. 229 on Subscriber Service Card

Transistor Chopper

A miniature transistor chopper with a noise level of only 35 microvolts is being marketed by the Cambridge Division of Airpax Electronics, Inc.

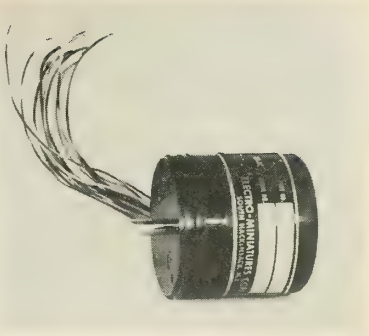
Operating on a new principle, the Type 7000 provides isolation between drive and signal circuits with precise switching action. Because no drive transformer is used, operation from d-c as well as square waves or pulses is possible. Typically the 7000, driven at 400 cps, has a noise level of 35 microvolts working into a 10k load.

Circle No. 230 on Subscriber Service Card

Continuous Rotary Switches

Electro-Miniatures Corp. is marketing electromechanical continuous rotary switches for timing, programing, sampling, commutating, and telemetering.

The switch design completely eliminates sliding or "wiping" action and



enables the unit to operate for millions of revolutions, with little or no contact deterioration—and essentially independ-

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offers unusual opportunities for:

INTERNAL AERODYNAMICISTS

Engineering, scientific or mathematics degree required; advanced degree desirable. Minimum of two years' experience necessary. Strong analytical background in aerodynamics and internal aerodynamics desired. Will analyze nozzle performance data and devise computer programs for nozzle design.

HEAT TRANSFER/HYDRODYNAMICS/THERMODYNAMICS SPECIALISTS

Engineering or scientific degree required, with two years' experience. Strong background essential in the analysis of fluid flow and the analytical problems involved in transient and oscillatory flows. Will perform hydrodynamic pressure-drop analysis, evaluate transient hydrodynamic behavior in closed loop fluid flow, conduct testing, and analyze results.

ROTATING MACHINERY ENGINEERS

Engineering degree necessary; advanced degree desired. Two to five years' experience in design of high-temperature turbines and rotary shaft seals. Experience with exotic fluids desirable. Aircraft or missile background advantageous.

THRUST CHAMBER ENGINEERS

B.S. or M.S. in aerodynamics or mechanical engineering. At least five to ten years' experience in heat transfer and thermodynamics. Will work in areas related to rocket injector, chamber and nozzle concepts.

DESIGN ENGINEERS

Three to ten years' experience. Salary and position commensurate with experience and education. Special capabilities desired include: stress analysis of pressure vessels and hydraulic components, vibration and fatigue analysis, metallurgy and fabrication techniques with ferrous and non-ferrous metals, and non-metallic fabrication techniques, as applied to light-weight structures for rocket engines.

DESIGN ENGINEERS/MECHANICAL GROUND SUPPORT EQUIPMENT

Engineering degree required. Two to ten years' experience in mechanical equipment design. Will have complete responsibility for design of individual items of ground support equipment, such as transport and handling equipment, hydraulic checkout equipment, nuclear remote handling equipment, and specialized maintenance equipment. Design responsibility will require extensive work on drawing board.

Send resume of experience to:

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ent of speed of rotation—to the temperature requirements of Specification MIL-E-5272.

Performance is equally good in both directions of rotation; critical angular tolerances can be maintained in both directions. No auxiliary systems are required and the switch is entirely self-contained.

Circle No. 231 on Subscriber Service Card

Digital Data Reader

A digital data-reader capable of reducing thousands of points of data per day is available from The Gerber Scientific Instrument Co.

The system consists of an X-Y reading-head, 16-in. paper or film transport, and keyboard. The reading head can be used separately, in conjunction with a 35-mm. film projector, or with Gerber's 66-in. scanner. Output is to typewriter, IBM keypunch, or punched paper tape.

Circle No. 232 on Subscriber Service Card

Vacuum Spectrometry

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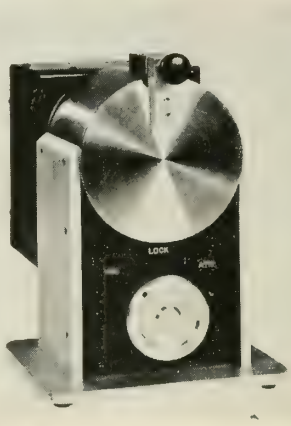

The SSR Model 301 vacuum chamber makes it possible to perform alpha and beta spectroscopy and counting without using complicated apparatus, purge gas, and special sample preparation. The stainless-steel chamber has a negligible background count and is readily decontaminated. Using the NPSG detector and matched low-noise hard-tube preamplifier, sample analysis time is reduced to a few minutes.

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new literature

SERVO MOTORS—Kearfott Division, General Precision, Inc., has published a revised edition of its publication intitled "Technical Information for The Engineer—Servo Motors, Motors Generators, Synchros" which details the theory, performance, application, construction, and testing of such rotary wound components as standard, high inherent-damping, viscous-damped, inertial-damped, and synchronous motors; precision tachometers; rate generators; damping tachometers; mechanical filters; integrating motor generators; and all types of high-performance synchros and resolvers.

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INFRARED INSTRUMENTATION—A brochure (Bulletin O-014), available from Barnes Engineering Company, is a collection of recently published articles on infrared instrumentation for space vehicles. These articles, reprinted from the technical press, discuss the design of horizon sensors and other infrared instrumentation for guidance, stabilization, navigation, and tracking.

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WAVEGUIDE WINDOWS — A comprehensive 12-page brochure describing waveguide pressure windows, their applications and installation suggestions, is available from Microwave Associates, Inc. The brochure provides the latest electrical and mechanical spicifications plus photographs and outline drawings with dimensions for over 100 microwave pressure windows in four styles.

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FILTER BROCHURE — A brochure now available is designed to provide the engineer-designer with a graphic picture of the ability of Wire Cloth Products, Inc., to met his needs for micronic filter assemblies. The book traces the history of the company, shows numerous photographic examples of the wide variety of precision filter assemblies it is currently producing, and includes in-plant pictures that illustrate capacity for producing in any quantity to the most exacting standards.

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contracts

AIR FORCE

$40,652,000—**Boeing Co.**, Seattle, for production of operational missiles and training equipment related to the *Minuteman* weapon system and for assembly and checkout of a *Minuteman* wing (two contracts).

$20,000,000—**North American Aviation**, Downey, Calif., supplemental contract for research and development on the *Minuteman* missile guidance and control package.

$17,500,000—**Boeing Co.**, Seattle, supplemental contract for development of *Dyna-Soar*.

$8,350,000—**Lockheed Aircraft Corp.**, Sunnyvale, Calif., for research, development and production of space satellite vehicles (two contracts).

$7,560,210—**International Business Machines Corp.**, Rockville, Md., definite contract superseding letter contract for fabrication of an air defense computer.

$6,931,000—**Martin Marietta Corp.**, Baltimore, supplemental contract for production of ground equipment for *Titan II* missiles.

$5,996,167—**Martin Marietta Corp.**, Denver, supplemental contract for activation of *Titan* sites at Ellsworth AFB, S.D.; Mountain Home AFB, Idaho; Larson AFB, Wash.; and Beale AFB, Calif.

$5,871,685—**Aerospace Corp.**, El Segundo, Calif., supplemental contract for systems engineering, technical direction and management services in support of ballistic missile and space programs.

$4,000,000—**Temco Electronics Division, Ling-Temco-Vought, Inc.**, Dallas for continued manufacture of actuators for the *Minuteman* ICBM.

$2,850,000—**Minneapolis-Honeywell Regulator Co.**, St. Petersburg, Fla., supplemental contract for development of the primary guidance system for *Dyna-Soar*.

$2,600,000—**Radio Corp. of America**, Camden, N.J., supplemental contract for production of *Dyna-Soar* communications and tracking equipment.

$2,512,500—**Western Electric Co.**, New York City, supplemental contract for research and development of the *Titan I* guidance system.

$2,287,000—**Space Technology Laboratories**, Los Angeles, supplemental contract for site activation engineering for *Atlas, Titan and Minuteman* missiles.

$2,090,000—**Lockheed Aircraft Corp.**, Sunnyvale, Calif., supplemental contract for research and development of satellite control systems.

$2,000,000—**General Electric Co.**, Syracuse, N.Y., supplemental contract for research and development of airborne guidance equipment in support of space programs.

$1,605,000—**International Business Machines Corp.**, Cocoa Beach, Fla., for rental of IBM data systems and components located at Patrick AFB and at Cape Canaveral Missile Test Annex for a period of 6 months (two contracts).

$1,290,000—**Radio Engineering Laboratories**, Long Island City, N.Y., definite contract superseding letter contract for production of communications equipment.

$1,250,000 — **Douglas Aircraft Co.**, Santa Monica, Calif., letter contract for production of *Thor* boosters.

$1,179,489—**North American Aviation**, Los Angeles, supplemental contract for production of launchers, aircraft modification kits, and related equipment for *Bullpup* missiles on F-100 series aircraft.

$644,813—**Sperry Rand Corp., Remington Rand Univac Div.**, St. Paul, Minn., for assembly installation and test of an antenna steering computer and control.

$600,000—**Defense Research Corp.**, Santa Barbara, Calif., for scientific study in the field of ICBM warfare.

$60,083—**Human Sciences Research, Inc.**, Arlington, Va., for research and development services on techniques in advanced aerospace command and control systems.

$55,000—**University of Colorado**, Boulder, for research directed toward the solar spectrum by photographic means from rockets.

$29,279—**Aerojet-General Corp.**, Azusa, Calif., for analytical studies of an *Exos* sounding rocket.

ARMY

$111,757,959—**Martin Marietta Corp.**, Orlando, Fla., primarily for production of *Pershing* weapon system (two contracts).

$28,363,356—**Raytheon Co.**, Lexington, Mass., for concurrent repair parts, field-maintenance test equipment production, ground equipment, assembly and checkout and engineering services for the *Hawk* missile system (seven contracts).

$11,192,430—**Western Electric Co., Inc.**, New York City, for production engineering services for *Nike-Hercules* missile system and for spare parts (17 contracts).

$2,126,866—**Sperry Utah Co. Div., Sperry Rand Corp.**, for ground handling and test equipment, publications, ground support and missile test items, for *Sergeant* missile (10 contracts).

$929,975—**General Electric Co.**, Syracuse, for HIPAR ORD-8 repair parts for *Hercules* missile (five contracts).

$929,848—**Raytheon Co.**, Lexington, Mass., for concurrent repair parts and rework of assemblies for *Hawk* missile systems (two contracts).

$500,000—**Martin Marietta Corp.**, Orlando, Fla., for feasibility study for *TOW* missile system.

$500,000—**McDonnell Aircraft Corp.**, St. Louis, for feasibility study for *TOW* missile system.

$500,000—**Hughes Aircraft Co., Aerospace Group**, Culver City, Calif., for feasibility study for *TOW* missile system.

$465,815—**Douglas Aircraft Co., Inc.**, Santa Monica, Calif., for spares for control indicator, control surface kits actuator assembly and ORD-8 spares (five contracts).

$290,574—**J. Hilbert Sapp, Inc.**, Orlando, Fla., for construction of G/M data transmitter building, AF Missile Test Center, Patrick AFB.

$315,000—**Columbia University**, New York City, for analysis of radar noise in the *Nike* and related systems.

$212,878—**Martin Construction Co.**, Cocoa Beach, Fla., for relocation of utilities for Pad 36B, Cape Canaveral Missile Test Annex, AF Missile Test Center, Patrick AFB.

$106,565—**Martin Marietta Corp.**, Orlando, Fla., for replenishment spare parts for *Lacrosse* weapon system (two contracts).

INDUSTRY

$750,000—**Hughes Aircraft Co.**, Culver City, Calif., from **General Dynamics**, for continued development of an advanced guidance unit for the *Mauler* tactical air defense system missile.

$120,000—**Universal Match Corp.**, St. Louis, from **Boeing**, for explosive parts for the *Minuteman* stage-separation system.

$69,000—**Guidance Technology, Inc.**, Santa Monica, Calif., from **Texas Instruments Inc.**, for an advanced model vertical gyro for stabilizing airborne antenna.

NAVY

$38,189,123—**Raytheon Co., Aero/Weapons division**, Waltham, Mass., for *Sparrow III* guided missiles.

$9,609,900—**Hercules Powder Co.**, Wilmington, Del., for continued effort on research and development of solid propellants.

$2,718,881—**Westinghouse Electric Co.**, Sunnyvale, Calif., for research and development effort on the *Polaris* launching system.

$1,756,715—**Texas Instruments, Inc.**, Dallas, for radar components.

$1,505,754—**Bendix Corp.**, Mishawaka, Ind., third contract for research and development effort on *Typhon* missiles.

$1,500,000—**Lockheed Missiles and Space Co.**, Sunnyvale, Calif., for ground test and training missiles in connection with the *Polaris* program.

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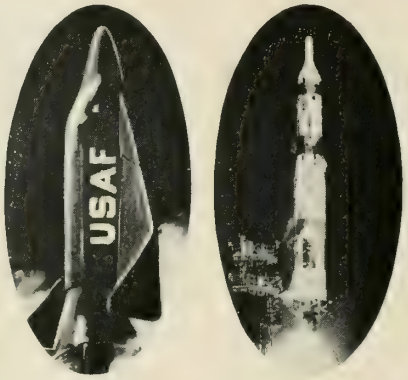

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ISSUE: MARCH 26, 1962

ADVERTISING CLOSING DATE: MARCH 5

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—when and where—

FEBRUARY

Western Electronic Week and Pacific Electronic Trade Show, Palm Springs and Los Angeles, Feb. 3-11.

American Society for Testing and Materials' Committee Week and Spring Meeting, Statler-Hilton and Sheraton-Dallas Hotels, Feb. 5-9.

Winter Convention on Military Electronics, IRE, Ambassador Hotel, Los Angeles, Feb. 7-9.

International Solid State Circuits Conference, Philadelphia, Feb. 14-16.

Golden Gate Metals Conference, Fairmont Hotel, San Francisco, Feb. 15-17.

American Institute of Mining, Metallurgical, and Petroleum Engineers, 91st annual meeting, Hotels Statler and Astor, New York City, Feb. 18-22.

Tracking and Command of Aerospace Vehicles, Institute of the Aerospace Sciences, San Francisco, Feb. 19-21.

Third Annual Symposium on Nondestructive Testing of Aircraft and Missile Components (Southwest Research Institute), Gunter Hotel, San Antonio, Tex., Feb. 27-Mar. 1.

MARCH

Institute of Radio Engineers, 8th Scintillation and Semiconductor Counter Symposium, Washington, D.C., Mar. 1-3.

Fifth Annual Technical Conference Society of Vacuum Coaters, Sheraton-Cleveland Hotel, Cleveland, Mar. 6-7.

Armed Forces Communications and Electronics Association, Cape Canaveral Chapter, symposium, Cocoa Beach, Fla., Mar. 6-8.

Flight Propulsion Meeting (classified), Institute of the Aerospace Sciences, Cleveland, Mar. 8-9.

First Microminiaturization Congress and Exhibition, sponsored by American Watchmakers Institute, Hotel Commodore, New York City, Mar. 10-13.

1962 Symposium on Packaging of Chemical Products, sponsored by Manufacturing Chemists Association, Inc., St. Louis, Mar. 13-14.

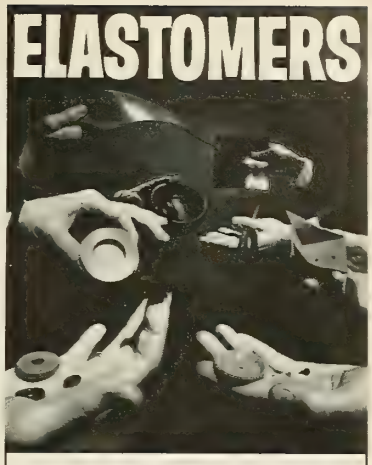
Goddard National Space Conference, sponsored by the National Rocket Club, Sheraton Park Hotel, Washington, D.C., Mar. 14-16. (Goddard Memorial Dinner on Mar. 16.)

Electrical Propulsion Conference, ARCS, Hotel Claremont, Berkeley, Calif., Mar. 14-16.

Third Symposium on Engineering Aspects of Magnetohydrodynamics, sponsored by University of Rochester, AIEE, IRE, IAS, University of Rochester, N.Y., Mar. 28-29.

APRIL

American Rocket Society, Launch Vehicles: Structures and Materials Conference, Ramada Inn, Phoenix, Ariz., April 3-5.



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Once Upon a Country

ONCE UPON A TIME, in a land long ago and far away, there existed a Kingdom so blessed by all the good things of life that sometimes it still is spoken of with awe when the wise men gather by the council fires in the evenings. Its men were tall, strong and proud. Its women were the fairest in the world. Its earth yielded up bountiful crops and the meat of its cattle was as tasty as the wine of its grapes.

The King was both good and wise. He ruled with a strong hand but he loved his people.

Rust grew on the pointed spears of the warriors and, in the warm sunshine, spiders spun their filmy webs across the shields hung on the battlements of the castle. It was not always thus. Many times, the Kingdom's tall, strong and proud men had gone forth to shed their blood in defense of their lands and their women. Many times, they had defeated the enemies of the Kingdom until everyone now feared the strength of these warriors and Peace was upon the land.

In the evenings, when the long shadows of the mountains sheltering the fertile Kingdom fell across the valley, the children gathered around the story-tellers to hear tales of valor in battles past.

The pleased laughter of the children was as music to the King's ears. The women ceased their chores to listen and the men homeward bound from the fields looked at one another and smiled. Never had life in the Kingdom been happier.

Then a small cloud appeared to darken this happiness.

One day, the King's Chief Advisor called upon him.

"King," he said, "the tiny kingdom of Ethelred is talking of war against us.'

The King was a man of action.

"Go at once and see that all our spears are sharpened and the cobwebs swept from our shields," he ordered the Chief Advisor. He summoned a messenger to his side.

"Proceed to the King of Ethelred and tell him we are prepared and that he cannot take us by surprise."

While the royal messenger was gone, the men of the Kingdom sharpened the spears and polished the shields, although many grumbled that this duty was interfering with the harvest and the wine-making.

When the messenger returned, he reported to the King that the warriors of the Kingdom of Ethelred were occupied with the making of many spears.

"They cannot fool us with that game," the wise King said and he ordered more spears to be made. The Kingdom busied itself with the making of spears until one day a spy appeared from the Kingdom of Ethelred.

"King," he said, "it appears we have made a mistake. The people of Ethelred are not making spears; they are making a strange new weapon which consists of a handle and a chain with a spiked ball at the end of it. It appears most deadly."

"Then," said the King, "we shall make just as many of this new weapon as they are making." So the weapons-makers of the Kingdom ceased making spears and began making the deadly new weapon with the spiked ball on the end.

This continued until the spy again returned from the Kingdom of Ethelred.

"King," he said, "it appears we once again have made a mistake. Our enemies are not making very many of those spiked ball items. They are making a great many of something called a catapult, which can hurl a stone a fierce distance. It appears to be an extremely deadly weapon."

"There will be no Catapult Gap around here," the King averred. He ordered his weapons-makers to stop making spiked balls and to concentrate on building catapults. The Kingdom, which now had three storehouses full of spears and four storehouses full of the spiked ball item, concentrated on producing catapults.

THE CATAPULTS were being emplanted at strategic locations around the Kingdom when the spy again returned from the Kingdom of Ethelred.

"King," he said, "you are not going to like this. The Ethelreds didn't build very many catapults after all. They have spent a lot of time growing wheat and raising cattle and they are building a boat to discover America. In addition, they have been seen rolling big rocks around the top of our mountain, which may be a new kind of weapon."

"You," said the King, "are a lousy spy." He fired the spy and reorganized the department. He ordered the Chief Advisor to get an America-discovering launch program under way at once. When the Chief Advisor asked about the mysterious new Ethelred weapon, the King told him: "We have three storehouses of spears, four storehouses of that spike ball item and all those catapults which the Ethelreds don't have. We also have an America-discovering project. We also have to get the grapes picked because there is a big wine festival coming up. And whoever heard of using big rolling rocks as weapons?"

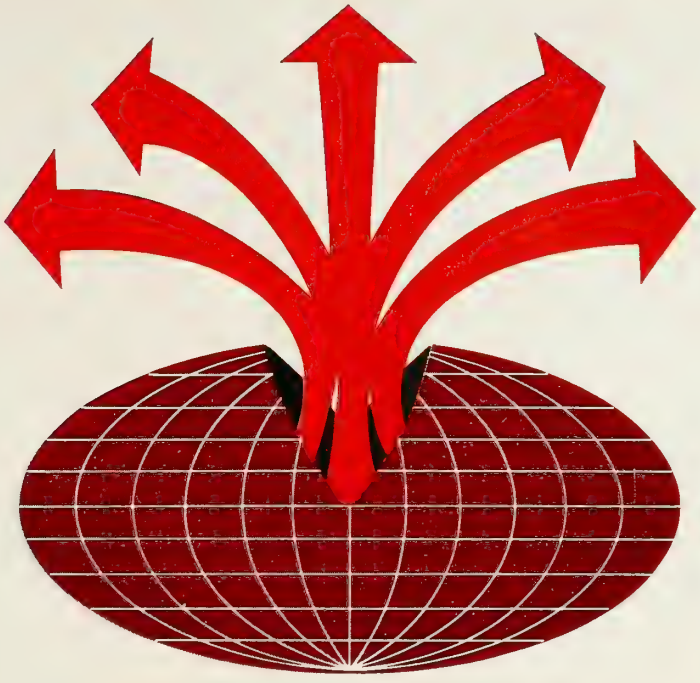
Soon, a messenger arrived from the King of Ethelred.

"Surrender," the message said, "or we will push big rocks down on your Kingdom."

"I would rather be dead than Ethelred!" shouted the good and wise King and a short time later he was. The Ethelreds pushed the rocks down the mountain, killed the King, destroyed the Kingdom and took away the fair women and the tasty wine. Nowadays, you don't hear much about the Kingdom.

MORAL: YOU NEVER KNOW WHEN SOMETHING IN ORBIT IS GOING TO FALL ON YOU.

William J. Coughlin



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US ARMY (Signal Supply Agency)—instruments and field studies relevant to seismic techniques for Missile Impact Location.

USAF (Systems Command/Hanscom Field)–development of VLF Electronic Seismometer with possible lunar probe application.

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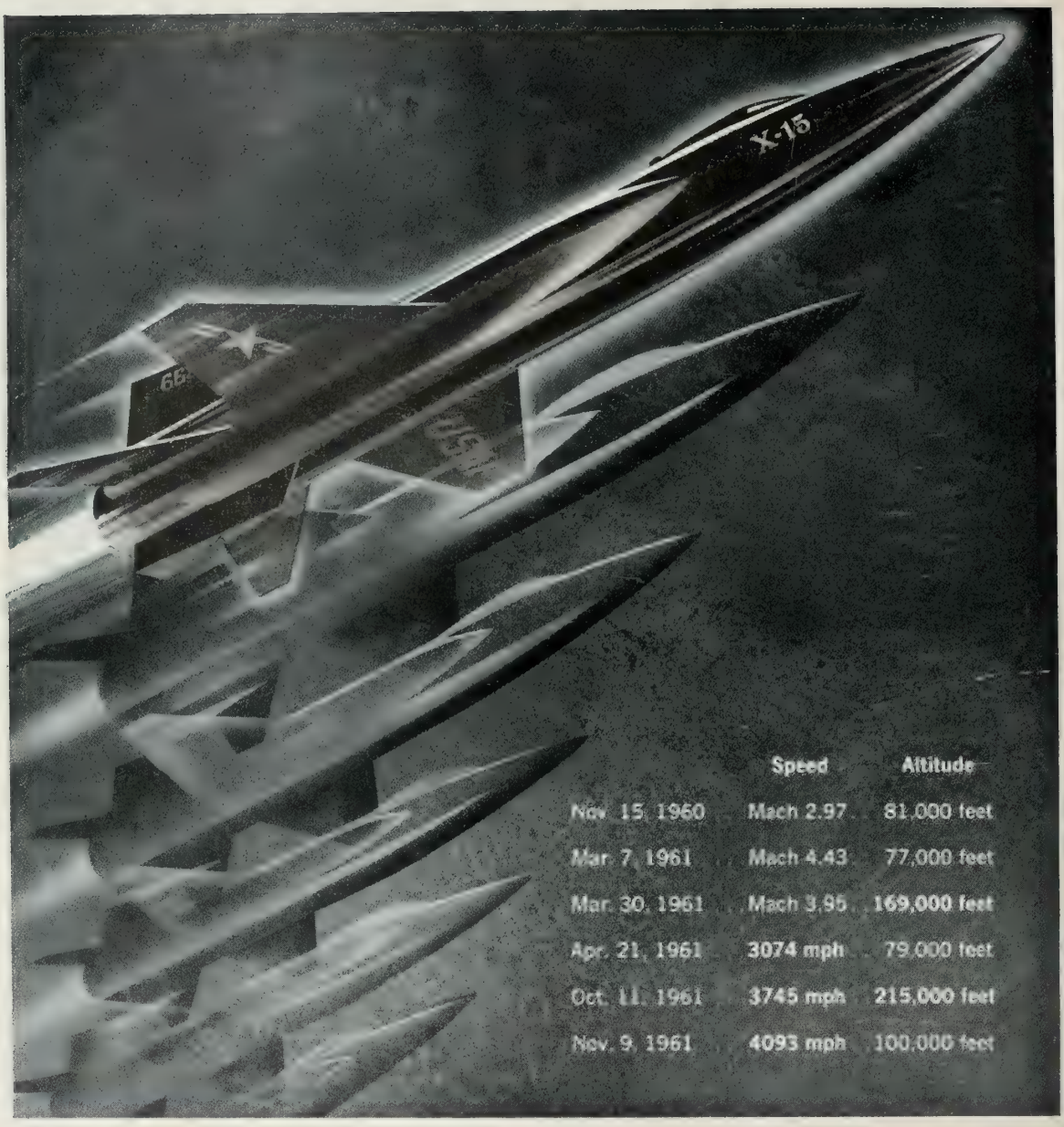

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FEBRUARY 5, 1962

missiles and rockets

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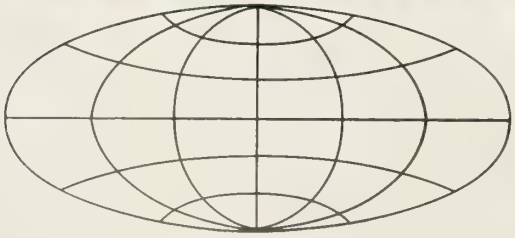

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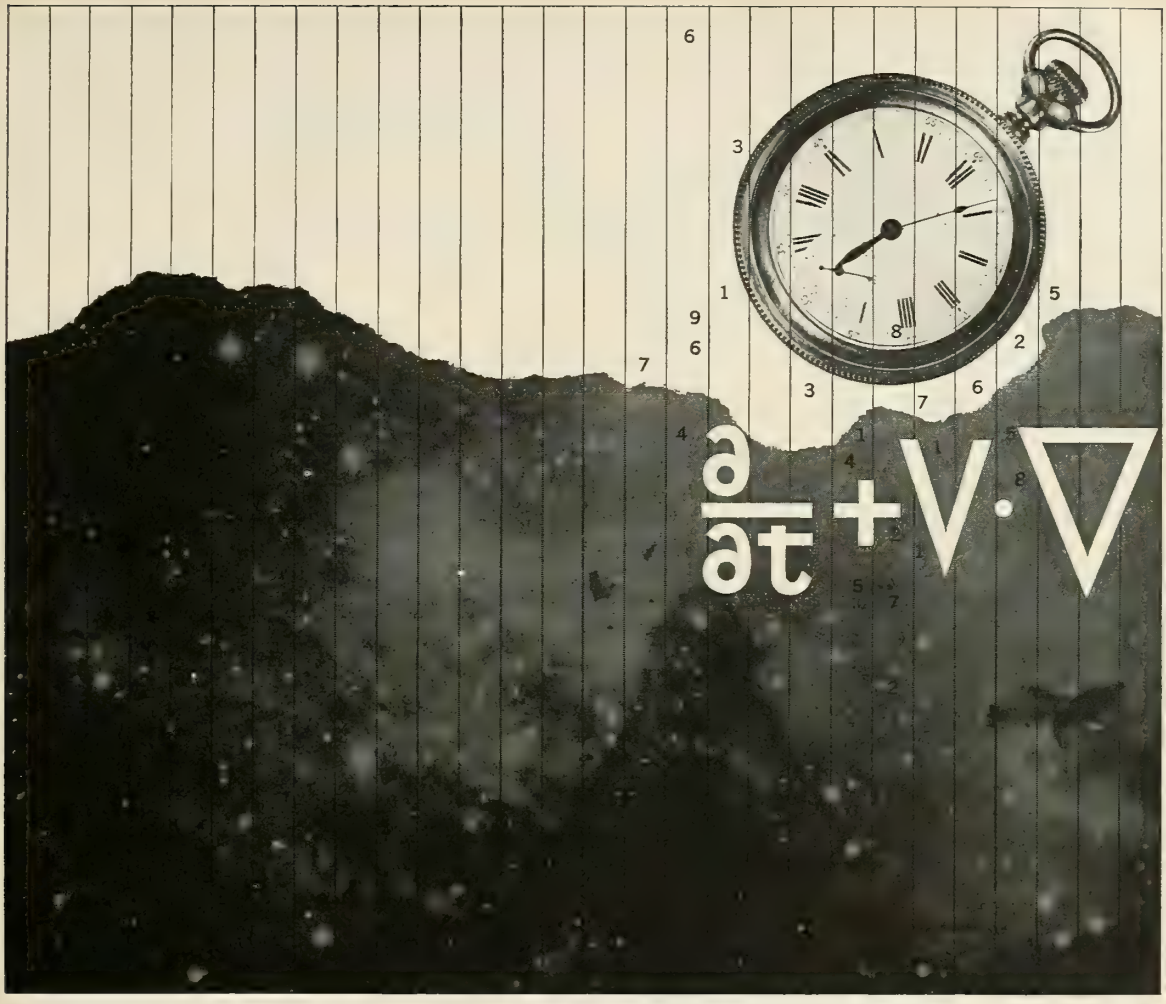

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Engineers, Scientists

what's your opinion:

1

ON HOW TO CREATE A REALISTIC SPACE SIMULATOR?

This is a question put to Bell Aerosystems last year by the Air Force. If you had been a member of Bell's technical staff then, you might have been one of those who developed the space environment simulation concept now being engineered into actuality here. It is based upon a high-resolution, closed-loop television system superimposing images generated by 3 studios. Many stimulating problems, however, remain to be solved in: development of an electronic planetarium, real time digital flight dynamics, television image insetting techniques, TV noise alleviation techniques.

2

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3

ON HOW TO PROVIDE AN ASTRONAUT WITH POSITIVE, FLEXIBLE STEERING CONTROL IN SPACE?

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The three problems high-lighted above are representative of the wide range of unusual challenges offered engineers at Bell. Others concern such diverse projects as advanced Agena* rocket engines for NASA's Ranger and Marine vehicles; Hydroskimmer (air cushion) amphibians for the U.S. Navy; battlefield surveillance systems; automatic checkout equipment; missile & drone recovery systems. Another important field at Bell is Inertial Guidance and Navigation Systems, many of which employ an appropriate member of Bell's family of Hipernas** inertial platforms. *If you would like to pit your talents against tough-calibre problems, look into current openings with Bell.*

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THE MISSILE / SPACE WEEKLY

missiles and rockets

Volume 10, Number 6 February 5, 1962

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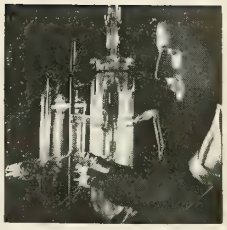
THE COVER

Dr. Gerald W. Sears, Manager of the Molecular Physics Lab at General Dynamics/Electronics, readies high-vacuum equipment for NASA-funded study of nucleation of crystals under space conditions. *See p. 15.*



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†U.S. Reg. Pdg.

38,261 copies this issue

Artificial Shortage?

To the Editor:

This is just to add an "Amen" to Mr. Harold A. Weinbaum's letter in M/R, Jan. 15, for his theory regarding the shortage of engineers.

There are many, many good engineers approaching 45 years of age who have hired, fired, trained and supervised young engineers for the past 10 to 15 years. Unless there is a change in the present attitude of most engineering organizations, the only thing most of the "45-year-olds" have to look forward to in the next 10 years is selling insurance or real estate. And what will the young engineer have to look forward to in his so-called old age!

What a waste of good engineering talent!

Also, what is the good of a retirement program when these older engineers are "eased out" before they ever reach retirement age, to make room for the younger ones?

W. C. Moore
Denver

To the Editor:

I would like to add a hearty "amen" to the views expressed in your Jan. 15 issue by Mr. Warren E. Hanson and Mr. Harold A. Weinbaum. I believe these two gentlemen have pointed out the two most important aspects of the so-called Scientist/Engineer Shortage. In fact, there is no shortage, but there very definitely is poor utilization of existing scientific and engineering personnel. This leads to an apparent shortage because, for example, three men are apparently required to achieve the same result that two men properly trained and supervised can produce.

The nation needs to fully exploit the talents of both "non-graduates" and "old engineers. Together, they can make a potent combination.

L. E. O'Rourke
Pittsburgh

To the Editor:

I wonder if you would be interested in a wife's-eye-view of the so-called engineer shortage? After sitting across the breakfast and dinner table from an engineer for 13 years and listening to his daily diatribes on what is wrong with the engineering profession—I feel qualified to discuss any related subject!

Mr. Weinbaum's letter on the problem of the old engineer is very true, and has encouraged me to inform you that the situation is even worse than he has pictured. One doesn't have to be that old to encounter difficulties landing an engineering job. Some of the barriers my 39-year-old husband is becoming aware of are so insidious as to be almost unbelievable. If we are indeed in the national peril that is pictured for us, someone should alert the job interviewers of this nation to the fact that there is an "engineer shortage." Other than age I can name five other barriers to obtaining a good engineering job:

1. The desired income level: The financial aspects of the job interview often have a poker-game atmosphere, with the interviewer offering no more than he has to and the applicant asking only as much as he dares. After years of struggling to get by on meager earnings, we have, after 12 years, reached a comfortable income level which provides adequate care for our children and allows a small saving each month, if we are faithful to the budget. We don't ask to be rich but we do ask to continue working at our present rate. Yet we have encountered interviewers who are shocked at our asking price. I believe the real shortage is in men who are willing to work for $600.00 a month—not in experienced engineers.

2. That "eternal" grade-point average: One of the first things the job interviewer asks is for the applicant's college grade-point-average. Not every engineer is a genius; on the other hand I do not know of any engineering schools who graduate idiots. In my husband's case, he went to college straight from three years of war. Before he settled down to serious study he collected some passable grades, and worse, that averaged with the good grades of the last two years of college resulted in a grade-point-average he cannot brag about. His work the past few years with one of the nation's largest aerospace companies has been of the most advanced and classified nature . . . Yet it doesn't seem to override that low grade-point-average. He has helped to create some of the fabulous technological advances which make his old college education obsolete . . . He continues to enroll in extra courses, in space-science lectures, etc. . . to what avail?

3. The prestige of having graduated from a Big Name School vs. the ordinary state college: The graduate of the Big Name School is snatched up regardless of other qualifications; as one executive we know told us, he wants to "upgrade" his organization. This is a type of discrimination as ominous as that of race and religion.

4. The Major Subject: My husband chose to major in Industrial Engineering, a field which he felt would be broad enough to cover any type of engineering he might later be called upon to perform. Now he finds that most people think of this as only "time and motion" study—if they even know that much about it . . . My husband has spent 12 years working in the E.E. and M.E. fields, yet he finds jobs listed under those headings automatically closed to him by the job interviewer.

5. The fear of looking for a better job: The job hunt is a shadowy world most engineers do not care to enter until absolutely necessary. Some we have talked to are not sure whether a job interviewer would contact their boss or not. They are afraid to look around for fear of losing the job they have. They have homes and obligations they dare not sacrifice. The costs of changing jobs even when expenses are paid by the new employer are practically prohibitive. We recently made a move in which we were lucky to have sold our home for a loss of only $2000. At the present time an engineer cannot settle down in an area, buy a home, or make long-range plans without making certain his company has one of the larger contracts to ensure long-range work. When we were dismissed by our floundering company last summer, we left behind us some several thousand employees literally quaking in their boots for fear they would be next.

The company we are with at the present time lost out in the recent contest for the new Space-Age contracts. There is sufficient work to last for awhile . . . but the thinking man must look ahead and secure his future. Wouldn't some sort of national survey be in order before we scream, "Panic, we don't have enough engineers!" It would certainly seem so to those of us who are available.

Oh, well, back to the dishes!

(Name withheld on request)
An Engineer's Wife
San Diego, Calif.

Industry Patent Practice

To the Editor:

I did some holiday reading and picked up one book that seemed to bring out a point one might consider when reading your editorial.

This book usually has flexible leather covers and gold-edged leaves. Quite a few people read into it, but very few read out of it. The resulting problems or numerous, to put it mildly.

This book is supposed to be the rule book of a large group of people, and I find it has some very-well-put phrases in it. One which might interest you is "Whatsoever ye would that others do unto you; do ye even so unto them." (This may not be the exact wording, but my memory is foggy early in the morning.)

Now if you and I agree on the points in your editorial, and big business doesn't —how are we going to convince them that we are right? We know they *do* want the Government to own the products of their creative ability, because they "do unto us" the same thing.

Do you believe we can get them to stop making their new employees sign those various forms the different companies hand one as part of the requirement for a job? Especially the forms that not only own one's creativeness while working at that particular place, but also from 1 to 5 years afterwards? . . .

Glen C. Horst
Santa Clara, Calif.

To the Editor:

I have just finished reading your editorial . . . in which you document and support the opposition of American industry to proposed government patent legislation. I am struck by the glaring inconsistency between industry's position in this matter and the kind of patent agreements which they require their own employees to sign.

I haven't had a chance to read the proposed legislation, but from your brief summary, it sounds like a paragon of generosity alongside the usual patent agreement. If you have never read one of these agreements, you have a real treat in store. The employee signs away all rights to any idea that he may ever conceive—whether or not it has anything to do with his employer's business, or was done on the employee's own time, or with his own resources. The justification given for this is that the employee is hired for his ideas, and his salary is a continuous payment for the ideas he develops. The same argument of course applies to a company hired to do research by the government.

Do not misunderstand; I am arguing neither for nor against the proposed patent legislation. I am simply making a plea for consistency. If restrictive patent agreements between government and industry destroy industry incentive and stifle free enterprise, then restrictive agreements between industry and its employees will also destroy individual incentive and stifle free enterprise. If industry wants to impress me with its argument against restrictive patent legislation, it must first clean its own house.

Eldon Eller
Duarte, Calif.

Offspring Out of Wedlock

To the Editor:

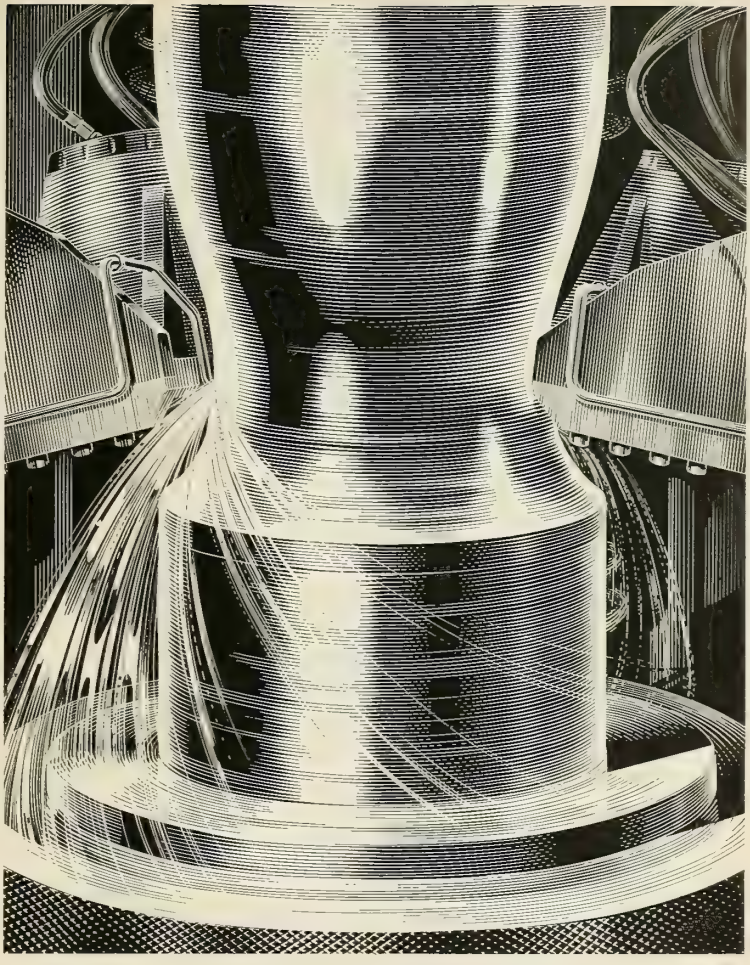
In your otherwise fine item on the formation of Vitro-Smith Corporation (M/R, Jan. 8, p. 37), the impression is given that Vitro Corporation of America and A. O. Smith Corporation have merged.

This has caused a considerable amount of confusion and concern. Vitro and Smith have formed a new jointly-owned company to combine Vitro's technical, engineering and project-management capabilities with the fabrication know-how of A. O. Smith. Vitro and Smith have not merged and indeed are continuing to go their separate ways. For example, Vitro Laboratories' role as the Navy's systems engineering coordinator on *Polaris, Tartar, Talos* and *Terrier* and Vitro Services' operations at Eglin AFB are not involved; nor are Vitro Engineering's architect/engineer assignments or A. O. Smith's activities.

Vitro-Smith will be concentrating on new efforts, particularly on space, nuclear and other advanced technical facilities for the Government. . . .

Vitro Corporation and A. O. Smith are very happy with the future potential of our joint offspring, but we hope M/R's readers will not forget that both companies continue to move forward individually as well.

Morton Salkind
Director of Public Relations
Vitro Corporation of America
New York



Space age potter's wheel

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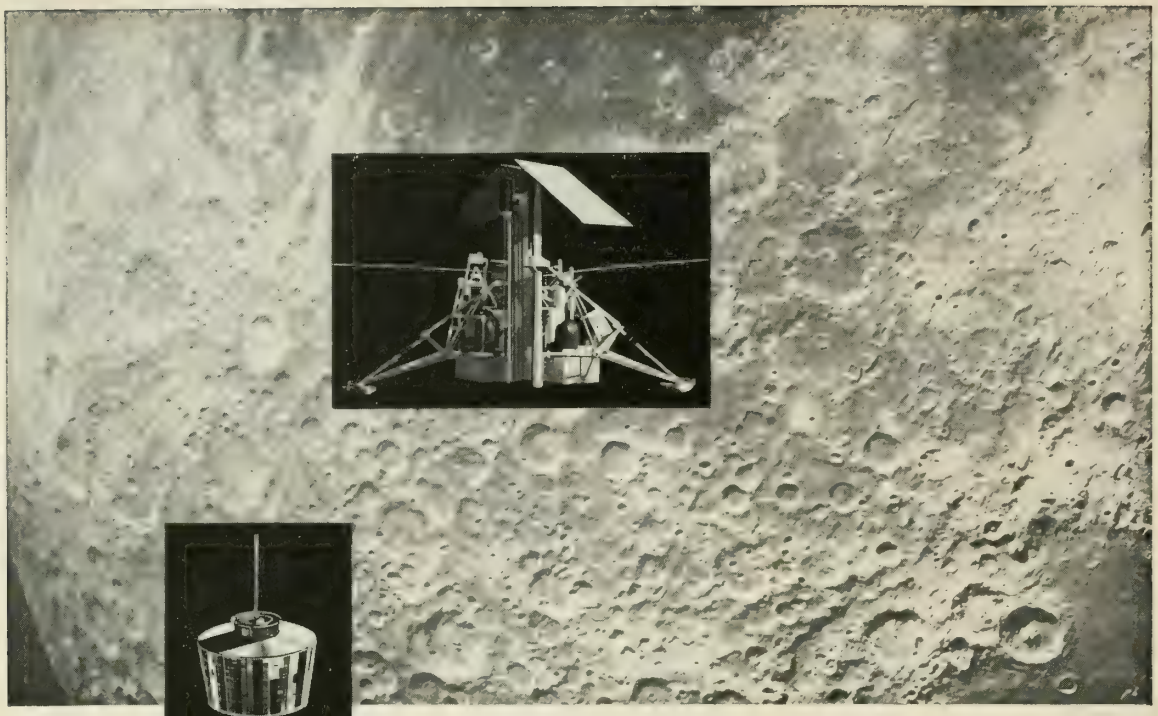

systems analysts:

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SURVEYOR (soft lunar landing spacecraft), SYNCOM (synchronous communications satellites), ARPAT (terminal anti-ballistic missile defense system), BAMBI (anti-ballistic missile defense feasibility study). These are a few of the many important and complex projects under design, development and study at Hughes.

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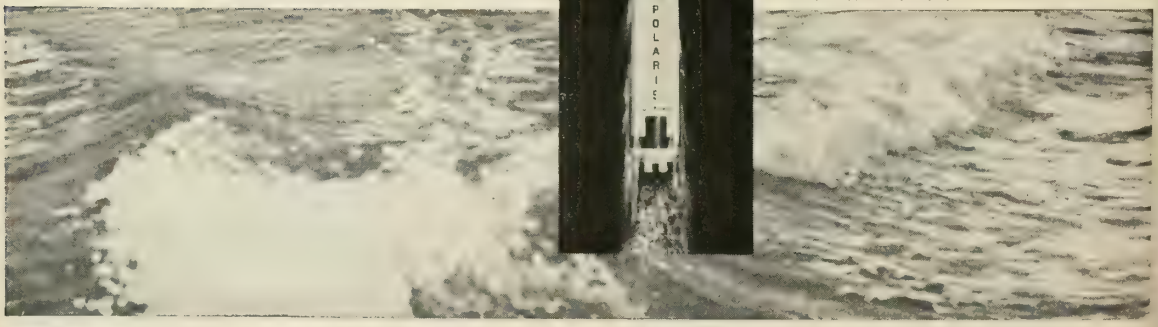

The Countdown

WASHINGTON

The New and Bigger ICBM

Martin Marietta's *Titan III* is a leading candidate in the Air Force competition for a third-generation ICBM capable of lofting heavier nuclear warheads. It could boost over 15 tons on any desired trajectory to the Soviet Union (see p. 13).

Reorganization in NASA

Major reorganization of NASA's Manned Spacecraft Center, currently moving to Houston from Langley, has just been completed. Of major interest to industry: appointment of new directors for NASA's manned spaceflight programs. James A. Chamberlain will head the *Gemini* project office; Charles W. Frick, *Apollo;* and Kenneth S. Kleinknecht, *Mercury*.

Navy May Unload PMR

Industry sources say the Navy is becoming increasingly disillusioned with the secondary role assigned to Pacific Missile Range. If the Navy receives the money it has requested for development of the Advanced Underwater Test and Evaluation Center (AUTEC) range in the Caribbean, it might be willing to turn PMR over to either the Air Force or NASA. It would prefer to get rid of a poor stepchild and concentrate on the AUTEC range.

Titan II Launch Set for Next Month

Launch date of mid-March has been set for Martin Marietta's *Titan II*, which arrived by air at Cape Canaveral last week. The Air Force booster has 435,000 lbs. thrust in the first stage and 100,000 lbs. second-stage thrust. Big change from *Titan I:* all-inertial guidance.

Saturn, Telestar Launches Slipping

Second launch of the *Saturn* booster is slipping into the second quarter of the year. NASA officials say technical problems causing the delay are minor. Launch is now expected in April. First launch of AT&T's *Telestar* communications satellite also has slipped a month. Scheduled to go in April, its firing was postponed due to a heavy Atlantic Missile Range schedule.

Florida vs. California

Political pressure is being brought to bear on NASA to have North American Aviation build the *Saturn S-II* stage in Florida. Odds are heavily against its being moved out of California, however.

Agena B Substituted for Centaur

The White House disclosed last week that the Lockheed *Agena B* will replace *Centaur* in initial firings of *Advent* communications satellites, indicating a further setback in the lagging *Centaur* program.

INDUSTRY

Commerce Scoops DOD

Industry firms are becoming increasingly irked with Department of Defense handling of company press releases. Recent example: announcement of the Army's *TOW* antitank missile contract award to Hughes, Martin Marietta and McDonnell was disclosed by the Commerce Department several days before DOD cleared company announcements of the award.

Contract Awards

Bethlehem Steel Co. receives a $66,268,000 Navy contract for construction of a nuclear guided missile frigate . . . Lockheed Aircraft Corp. gets an additional $3,450,000 for R&D work on *Midas* and *Samos* . . . Aerojet-General adds another $1 million to its contracts for instrumentation kits for *Titan* boosters . . . Hughes Aircraft wins a $1,092,986 award for a satellite communications terminal.

Scientists Protest Atmospheric Tests

Some of the industry's top scientists were among those joining in the protest to President Kennedy last week on further nuclear testing in the atmosphere. The Council of the Federation of American Scientists approved the protest statement at its annual meeting in New York. Technical gains in such areas as antimissile development were alleged to be outweighed by political and propaganda losses.

Army Moves the Moon

Firms working on lunar exploration studies will have to revise their target estimate. The Army Map Service reports the mean distance from the earth to the moon is 238,866 mi., nine miles more than the figure which has been accepted for decades. The figure, based on three experimental methods, is said to be accurate within a mile.

INTERNATIONAL

Russian Missile Subs Pose Threat

Russia now has the capability of launching nuclear-tipped missiles against the U.S. from submarines lying off the coast. That was the closed-door testimony of Adm. George W. Anderson, Jr., Chief of Naval Operations, to the Senate Armed Services Committee last week. He said the Soviet undersea missile menace is a positive threat and that the Russians are expected to have soon sub-launched missiles capable of greatly exceeding the present 350-mi. maximum range.

Soviets Investigate Moon Surface

Russian astronomers who have been using radio waves to investigate the surface layer of the moon to a depth of one meter report that it is not dust, but a very light porous mass. Temperatures on the surface of the moon are said to be −150° Celsius at night and +115° during the day.

French Firm Ups Sales

Matra Co., the French missile firm associated with Breguet, reports a 30% increase in sales during 1961, with a further jump expected this year.

NERVA Contract Awarded: RIFT Bidders Are Selected

The U.S. kicked off major funding in Project *Rover* with the award of an estimated $500-million contract for development of the *NERVA* engine to Aerojet-General Corp. and Westinghouse Electric Corp.

NASA added further impetus to the program with the selection of three firms to bid on the contract for the *RIFT* nuclear rocket stage which will flight-test the engine.

The firms—General Dynamics/Astronautics, Lockheed Missiles and Space Co., and Martin Marietta Corp.—will be bidding on a contract worth about $300 million, NASA officials estimate.

NASA placed no official estimate on the value of the *NERVA* contract, but officials estimated it could easily reach a half-billion dollars. Under the terms of the five-year contract, Aerojet-General—as prime contractor—and Westinghouse—as its principal subcontractor—will build 30 of the engines.

Work to be performed through Sept. 30, 1962, is expected to cost approximately $26.6 million. Westinghouse will receive $8.5 million of the total, the remainder going to Aerojet.

The two firms were awarded a temporary six-month contract last July. The new follow-on contract gives them permanent responsibility for *NERVA* through September, 1966 (M/R, Dec. 11, 1961, p. 15).

The *RIFT* contract expected to be awarded in late April or early May calls for the development of only six stages, which are scheduled for flight-testing in the 1966-67 period.

If the nuclear rocket program is successful, however, many more will be built. The *RIFT* stage with the *NERVA* engine is slated for use as an upper stage for NASA's advanced *Saturn* and *Nova* launch vehicles.

The nuclear stage would permit the advanced *Saturn* to make direct flights to the moon and give *Nova* the capability of making long manned and unmanned interplanetary flights.

Thirty-three firms attended a first phase preproposal conference for the *RIFT* contract which was held at Marshall Space Flight Center, Dec. 7.

In addition to the three firms selected to submit detailed bids, two others—Douglas Aircraft and Space-General—submitted initial bids on Jan. 3.

The *RIFT* contractor will be responsible for designing the stage, and fabricating and assembling it at NASA's Michoud Operations Plant. The firm will also conduct certain component and full systems tests, as well as test and checkout items related to eventual flight testing.

The space agency announcement said the initial work will emphasize research and development tasks required to answer critical technical problems.

The *NERVA* engine development is under direction of the joint AEC-NASA Space Nuclear Propulsion Office which controls the Project *Rover* program.

The nuclear reactor to be used in the *NERVA* engine will be based on the reactor technology under development since 1955 at the Commission's Los Alamos Scientific Laboratory. Four reactors have been ground-tested at the Commission's Nevada Test Site: KIWI-A in 1959; KIWI-A Prime and KIWI-A Three in 1960; and KIWI-B 1A in 1961. All four used gaseous hydrogen as the propellant material. Further tests in the KIWI-B series are expected to use liquid hydrogen.

The contract covers continued engine design effort; research and development on engine components and subsystems, including work on the propellant feed system, reactor and engine control systems, nozzle, remote handling system, mechanical testing of reactor core components, bearings and seals, and examination of systems to assure safe operation; performance of work responsive to the needs of the Los Alamos Scientific Laboratory in the conduct of reactor tests; preparation of detailed program plans; and assistance in the design of test facilities.

Shots of the Week

U.S. military missiles chalked up an impressive list of successful launches including the first intercept of a simulated enemy ICBM by the Army's *Nike-Zeus* antimissile missile on Jan. 26.

In other important shots, the Air Force successfully launched its *Minuteman* and *Titan I* ballistic missiles.

The *Minuteman* shot on Jan. 25 was the fourth launch from its silo launch pad. The "Instant ICBM" roared 3200 miles downrange and plunked a dummy warhead on a target in the mid-Atlantic.

The *Titan I* launch on Jan. 29 was a double milestone for U.S. defense. It marked the 50th and last developmental flight in the *Titan I* series and the first launch using the all-inertial guidance system developed for the advanced *Titan II* missile.

The 98-ft., two-stage missile successfully hurled its dummy warhead at a target 5000 miles away.

The rocket closed out its testing program with 37 successes, 9 partial successes and 4 failures.

The *Nike-Zeus* success is expected to bring renewed pressure on the Administration to release production funds for the missile.

The weapon — launched from Point Mugu, Calif. — theoretically shot down the electronically simulated enemy ICBM heading toward the U.S. at a speed of 1400 miles.

An Army spokesman said "This proves that *Nike-Zeus* can do the job."

MA-6 Snarled by Fuel Troubles

Further postponement of the *MA-6* manned orbital launch beyond the new Feb. 13 target date is now likely.

Latest roadblock keeping astronaut John Glenn out of orbit was trouble in a series of regulator boxes controlling fuel flow to the *Atlas* booster's engines. This, Project *Mercury* sources said, could have resulted in launching Glenn into a dangerously high orbit.

There was also a leak in the *Atlas* fuel line through which kerosene was seeping into the insulation separating the fuel from liquid oxygen. This is the same problem which delayed the *Ranger III* flight for five days.

First slated to go on Jan. 24, the spacecraft environmental control sys-

tem and bad weather forced consecutive postponements to Jan. 27 and Feb. 1.

Reports that the *Atlas* now at the site would have to be replaced—bringing a delay of a month or worse—were denied by NASA officials, who said they believed they could repair the booster on the pad.

JFK Reports Space Progress

President Kennedy told Congress that the United States made significant progress in space activities in 1961, including planning for such projects as manned exploration of the moon, Mars and Venus.

The President's annual report to the House and Senate on NASA was devoted largely to a review of previously announced programs.

He forecast even greater strides in the coming fiscal year, for which he has asked total space funds amounting to $5.5 billion—an increase of $2.4 billion over Fiscal 1962.

"It is the policy of the United States that activities in space be devoted to peaceful purposes and during 1961 we made significant progress in that regard," he said. "Such progress included space projects to help keep the peace and space projects to increase man's well-being in space."

Washington Industry Notes

Air Force Systems Command's Gen. Bernard A. Schriever has joined the campaign against elaborate and costly proposal presentations, informing AFSC commanders that future evaluation of contractor proposals will be based "primarily upon comparative technical and managerial abilities of the contractors—responsive to requirements being procured." . . . The Joint Internal Revenue Taxation Committee, after more than a year of study, has issued a 148-page long-awaited report on the Renegotiation Act. Recommendation: A two-year extension of the act with no changes . . . Sen. Paul H. Douglas (D-Ill.) has tagged the lunar landing program "purely a stunt to get there before someone else." He says there is a serious question whether the U.S. should spend money on *Apollo* and cites a personal poll of members of the American Astronomical Society which he says reveals that one-third of the astronomers feel a manned lunar landing is not desirable.

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Ranger—What Might Have Been?

Some NASA experts believe shot that went wide might have impacted if Johannesburg had had command

by Richard van Osten

GOLDSTONE, CALIF.—Lunar impact of *Ranger III* might have been possible if NASA's Johannesburg deep-space tracking station had been provided with command capability.

The South African site, one of three permanent stations in the Deep Space Instrumentation Facility directed by the Jet Propulsion Laboratory for NASA, acquired the *Ranger III* vehicle approximately 10 minutes after injection.

Since it was the first station to lock on, and since it was in contact for the next 11 hours, some space agency officials believe that trajectory error could have been corrected early enough to effect a collision course.

JPL's Goldstone control station did not acquire the vehicle until some 12 hours after injection.

Ironically, Johannesburg already has the necessary equipment, but its command capability will not be operational until April or May. This still may not be in time for the *Ranger IV* launch, due in late April or early May, NASA said.

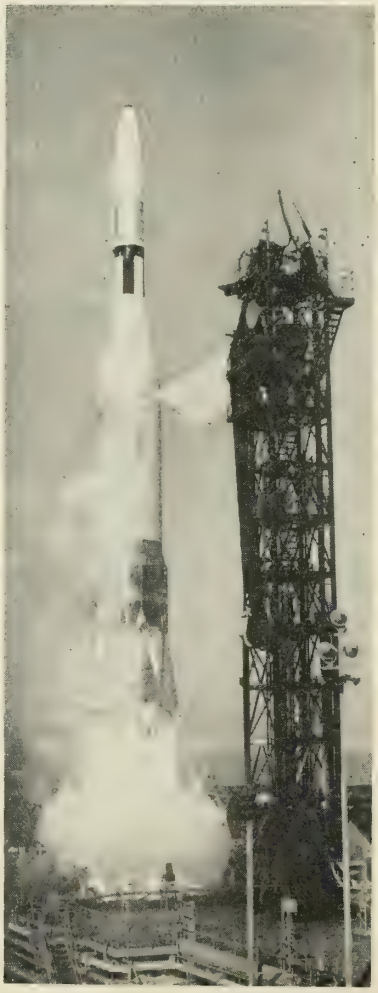
An opposing school of thought within NASA holds that Johannesburg could not have made a useful correction even if equipped with an operational command capability. In defense of this reasoning, it is asserted that Johannesburg did not have enough time to determine what was wrong and what to do about it. It also is noted that the *Ranger*'s high-gain antenna had not yet locked on to earth and that the vehicle was not designed to make a relatively immediate correction or mid-course maneuver.

However, a number of officials, including many at JPL, believe the course could have been corrected by Johannesburg or even Woomera, Australia, if command equipment had been installed at those points.

• **Plus and minuses**—JPL technicians now are busily analyzing and evaluating data returned from the less-than-successful launch of Jan. 26. It may be weeks before any meaningful results are obtained.

The shot pointed out one important fact, however: the mid-course correction and maneuver were feasible and they were performed with complete success by the Goldstone Tracking Station.

Goldstone made initial acquisition of *Ranger* early Saturday morning at approximately 0042 hrs. (Pacific Standard Time). Vehicle velocity was determined to be 5546 mph at a distance of 87,759 st. mi. from earth. By that time it was known that the course was such that the vehicle could not impact the moon as planned. JPL then decided to accelerate the vehicle in an effort to allow it to come as close to the moon as possible under the circumstances at that time.



HAPPY START—Ranger III takes off on Jan. 26. Early stages of trip were successful, but shot missed by 22,862 mi.

About 30 minutes after initial acquisition, Goldstone verified proper vehicle spatial orientation—the high-gain directional antenna had locked on the earth. (There was some concern it might lock on the moon and sun rather than the sun and earth, although corrective maneuvers were possible.) The earth-lock was verified by a 30-db increase in telemetry signal strength over that previously achieved by *Ranger*'s omnidirectional antenna.

At 0123 PST, the all-clear command was given; at 0127, the first mid-course guidance command was sent, received and stored. A second command was sent about 2 minutes later. It was then verified that all guidance information had been received and stored. Telemetry signal strength was about —110 dbm. All experiments were working.

In preparation for the mid-course maneuver, a switch to the low-gain omni antenna was made at about 0157. The antenna changeover was necessary since the hi-gain antenna had to be moved out of its earth-lock position before firing the mid-course rocket engine. The engine was expected to boost vehicle speed by about 80 mph.

The mid-course maneuver called for a 116° change in pitch, a 10° change in roll, and a hoped-for velocity of about 36,000 fps. The execute command was given at about 0200 hours. Success of the maneuvers was verified at 0227, when it was determined that the high-gain antenna again had acquired the earth. At that time, vehicle position with respect to earth was lat. 17.86° South,

long. 70.65° West. Vehicle velocity was estimated at 5418 mph at a distance of 100,398 mi. The vehicle had completed all assigned tasks.

When the switch was made to the omni antenna, JPL reported that telemetry strength dropped to below threshold at both Goldstone receiving sites. With the signal strength down to about −142 dbm, one Goldstone station lost automatic track and went on aided track; the other station was still on lock, although telemetry-received signal intensity remained below threshold.

Doppler track was reinstated in about 5 minutes, however, and the telemetry signal level came back up rapidly and was locked up again in about 10 minutes.

At 0852 Sunday, Goldstone sent a terminal pitch-maneuver command to *Ranger III* calculated to aim the television vidicon lens at the moon's leading edge. Distance then from the moon was about 31,000 mi. Three maneuvers involved in this action were executed at 0922 AM.

At 0948 the vidicon lens cover was opened. Telemetry reported this event completed at 0949, and the crook holding the omni antenna atop the retro motor and landing capsule assembly was released and moved outward at an angle of 45° to the main craft. At 0952 the 30-minute warmup for the vidicon was started. All operations were performed as designed and programed with the exception that the high-gain antenna did not re-position itself into the earth-lock position.

Ranger III almost made the grade. When the TV transmissions began, the antenna malfunction caused a drop in TV signal strength received at Goldstone. The station has a −130 dbm threshold for even marginal signals, for good images about −115 dbm.

Before the terminal maneuver, when the high-gain antenna was pointed at the earth, the received signal was −118 dbm. Following loss of the earth lock, signal strength dropped to −150 dbm —an intolerable loss factor.

During the 41 minutes that *Ranger* was "visible" to Goldstone for TV transmissions, the signal was so covered with noise as to be almost completely useless, scientists said.

• **Lunar images doubtful** — The Woomera, Australia, station next picked up the tracking, but that station has no TV readout equipment; therefore the tapes will have to be sent to JPL for detailed evaluation before any results are known. This will require a great deal of time, and JPL spokesmen say they hold little hope of uncovering any real information.

The vehicle apparently did accept its "second" maneuver when it pointed itself at the moon. All but the high-gain antenna was working properly. There was no attempt to launch the landing capsule—it was too far from the moon to be useful. Closest pass to the moon was at 4188 mph and 22,862 st. miles at 1523 hrs., Jan. 28.

Both Goldstone and Woomera tracked the capsule as well as the basic vehicle. Goldstone held it for 8 hours; tracking time by Woomera is not yet known.

Ranger by now has passed into a heliocentric orbit similar to *Pioneers IV* and *V*.

The solar sensors were cut off after the terminal maneuver when vehicle attitude no longer had the sun as a reference point and was deprived of solar power. Some transmissions were being received Sunday from the silver-zinc batteries. At best, the vehicle could operate only a few hours at design temperatures.

The vehicle attitude caused some spacecraft elements to heat and some to cool beyond thermal operating limits. The transmitter was expected to die after a few hours. Also, by this time *Ranger* should be tumbling. The lunar capsule transmitter can be expected to transmit for some time on its long-life batteries. Those signals will be used to track the spacecraft during the periods when the capsule antenna is oriented to earth during tumbling.

Orbital elements of *Ranger* include predicted perihelion of 91,503,314 st. mi., an aphelion of 108,133,845. Eccentricity will be 0.0833. Inclination to the plane of the ecliptic will be 0.3988°. Orbital period is estimated at 406.439 days.

Ranger IV and *V*—scheduled to be launched later this year—have the same mission as *Ranger III*.

Rangers VI through *IX*, which will be launched in 1963, will have a battery of six TV cameras capable of discovering objects 1 ft. in diameter on the lunar surface.

Ranger III's cameras take 200-line pictures.

Ranger VI through *IX* will have 600-line pictures—a little better than current home television sets. ⌘

DOD Picks Agena D Upper Stage

THE DEFENSE Department has decided on the Agena D launch vehicle as the standardized upper stage for its large space boosters.

The Agena D will have the same thrust and burning time as earlier models, but will be modified to fit all types of payloads.

NASA officials are also considering the use of Agena D as their standard upper stage. A final decision is expected in about two months.

The stage will be used on Titan II and Titan III vehicles as well as other primary boosers. It will boost such payloads as reconnaissance and communications satellites and Dyna-Soar, as well as other manned spacecraft.

The DOD decision apparently puts into limbo—at least for the moment—plans for the Agena C upper stage, which would have used additional propellant to increase its burning time and payload.

Lockheed Aircraft Corp.—prime contractor for Agena—has already received a DOD contract for Agena D, and work on its development is progressing. Meanwhile, the Air Force continues analysis of the Titan III configuration.

Present discussions primarily concern the two 120-in. solid motors to be strapped around the Titan II first stage.

Final decisions, as well as the awarding of the launch vehicle contract to Martin Marietta Corp., are expected about mid-March.

Two of the five-segment solid motors, with the 430,000-lb. Titan II first stage and the 100,000-lb. second stage, are expected to be able to put 29,000-lb. payloads into near-earth orbit.

Titan III will ultimately serve as the standard space booster for the Air Force. While attempts have been made to interest NASA in its use, space agency officials thus far say they have no mission which can use it.

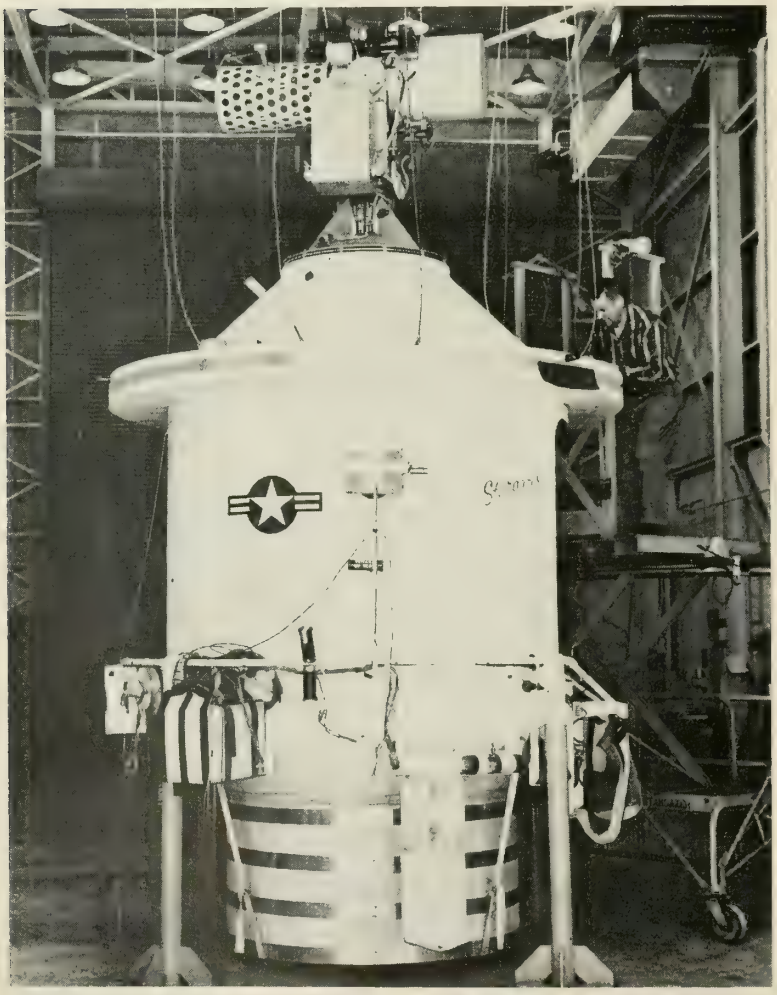
Six firms have been invited by the Air Force to submit proposals for the development of the 120-in. solid motor: Aerojet. Lockheed Propulsion, UTC, Thiokol, Hercules and Atlantic Research.

In addition to its space potential, the Air Force also is interested in Titan III as its next-generation ICBM, capable of lobbing heavy warheads at the Soviet Union from any direction, including a trajectory from the U.S. over the South Pole to Russia.

Biggest Astronomical Advance Since Telescope?

Project Star Gazer aims at giving balloonists first look through telescope fully stabilized over most of atmosphere

by William Beller



STAR GAZER gondola, fully assembled with 12½-in. reflecting telescope on roof, is given final touches prior to its scheduled launch early this month.

TWO UNMANNED BALLOON flights are scheduled early this month as a prelude to an astronomical experiment that may be as important as the invention of the telescope in widening man's knowledge of the universe.

If the test flights are successful, a professional astronomer will ascend late next month to make observations through the first fully stabilized telescope ever located above most of the earth's atmosphere.

This is project *Star Gazer*, sponsored by Air Force Cambridge Research Laboratories and under technical direction of Dr. J. Allen Hynek, chairman of Northwestern University's astronomy department.

Balloon pilot will be Captain Joseph W. Kittinger, Jr., of Air Force System Command's Aerospace Medical Research Laboratories.

William C. White, of the U.S. Naval Ordnance Test Station, will be balloon astronomer and observer.

• **Cheap tracking stations** — Hynek says that two technical advances at last make balloon observatories feasible: lightweight gyroscopic mechanisms have been devised that can stabilize a relatively free body, such as a telescope, in space; and giant plastic balloons have been developed.

As a result of the almost clear window open to observers on the fringes of the earth's atmosphere, Hynek foresees balloon-borne observatories used to optically track probes sent to Mars and Venus. Without atmospheric "noise," telescopes may even be able to watch space vehicles millions of miles away.

Hynek also hopes to see national balloon observatories set up, just as national radio observatories have recently been established to study unexplained radio emissions coming in from outer space.

Hynek admits that satellite observatories will be needed in studying ultraviolet light from space, because balloons can't rise above the tenuous ozone layer, which absorbs the ultraviolet. For observations in the visual and infrared regions of the spectrum, however, Hynek maintains that balloon observatories are far less expensive and immediately practicable, and yield easily recoverable data.

The first manned flight will have three experiments aboard; if the flight is successful, it will be followed by a series of others.

A 12½-in.-aperture telescope and the instrument package for the three experiments are mounted side by side on the gondola's roof. When its turn comes, each experiment "looks" through the telescope. This is done by having

the experiments on a revolving turret, which on command places any experiment at the focus of the telescope.

• **Twinkle, twinkle little star**—The first experiment is to measure the turbulence of the atmosphere. (If a movie camera were taking pictures at the focal point of a telescope located on earth, and if these pictures were perhaps of a star photographed against crosshairs, then the image would be seen to wander. This results from atmospheric turbulence above the observatory, and causes relatively poor definition in celestial photographs.) Turbulence is expected—but far less than an earth-bound observer would experience.

The second experiment calls for a photoelectric cell to measure variations in star brightness caused by high-altitude turbulence. This variation or twinkling is called "scintillation," and affects the accuracy of the photoelectric measurements of light from stars. After a certain height is reached, it is expected that most of the scintillation will be gone.

The third experiment uses an infrared detector—a lead-sulfide cell—to tell how water vapor in the air affects light coming in from stars and planets (as the dryer stratosphere is approached, the effect should be sharply lessened); and to give some of the characteristics of the light itself.

• **How I wonder where you are**—A 12½-in. Cassegrain reflecting telescope will be used for these experiments. Instead of looking through it, the observing astronomer will orient the telescope by aiming a small tracking telescope slaved to the larger instrument. Once this is done, the Cassegrain is locked on its target despite moderate pitching and turning of the gondola.

Precise stabilization is the outstanding feature of the experiment, and this will be the first time a balloon-borne telescope has had this capability. It will give observers the advantage of a ground-based observatory plus the bonus of a clear view of the sky.

The telescope's stabilization platform, developed and built by Massachusetts Institute of Technology's Instrumentation Laboratory, is made up of a gyro-stabilized platform that nullifies the effects of gondola motion, and a star-tracking mechanism that locks the telescope on target after an observer aims the instrument by means of a servo control.

• **Looking backward**—Though *Star Gazer* is pioneering in high-precision manned-balloon observatories, Hynek explains that it is by no means the first balloon observatory.

The first flight of a manned-balloon astronomical observatory was made in 1956 by Blackwell and DeWhirst of the University of Cambridge, England, and Dolfuss of Meudon Observatory, France. Reaching about 40,000 ft., the flight did not escape enough of the atmosphere to eliminate star-twinkling and to see infrared radiations.

Then, in 1957, under an unmanned-balloon project called *Stratoscope I*, headed by Princeton University professor Martin Schwarzschild, a 12-in. telescope was lifted to altitude above New Brighton, Minn. This was the start of a project that two years later yielded spectacular photographs of the solar surface.

A follow-on project called *Stratoscope II* is aimed at sending a 36-in.-aperture telescope to altitude this summer (M/R, Oct. 2, 1961, p. 28). However, the stabilization system is not designed to be nearly as sophisticated as that on *Star Gazer*.

Two years ago, Dr. John Strong of Johns Hopkins University directed a manned-balloon project, which established presence of water vapor on Venus.

• **The aerostat**—Made of two-mil polyethylene, the 200-ft.-dia. *Star Gazer* balloon is designed to reach a ceiling of 87,000 ft. Made by General Mills, Inc., of Minneapolis, the vehicle fully distended will displace 3,200,000 cu. ft. of air.

About the Cover

A NASA-sponsored study in cosmic chemistry may reveal how cosmic dust is formed and what part, if any, it plays in the genesis of stars and planets.

The project's immediate aim is to find out how solids form out of vapor when the atoms are as sparse and their vibrations as slow as they would be in the cold emptiness of space.

Initial studies are being made with zinc because of its desirable physical properties and the way it forms crystals upon condensing.

At General Dynamics/Electronics, where the work is being done, scientists are studying how the metal vapor nucleates in an ultra-high vacuum where the temperature is about −380°F.

It is expected that later work will be done with other elements, and perhaps even with some organic compounds.

Monitored by NASA's Goddard Space Flight Center, the project is under the scientific direction of Dr. Gerald W. Sears, manager of GD's molecular physics laboratory.

Sears and GD principal scientist Dr. John B. Hudson designed and fabricated the complex glass apparatus used in the experimental work.

A conventional stratospheric balloon-gondola system is used in *Star Gazer*. A recovery parachute 83 ft. in diameter is strung out in extended position below the balloon. In an emergency, the balloon is separated from the parachute by means of an explosive bolt, and the parachute lowers the gondola, which hangs beneath the parachute, safely to the ground.

The balloon is controlled by the pilot, who uses an electromechanical valve in the balloon apex to release helium for a descent, or drops ballast of fine steel dust for an ascent.

The gondola is an aluminum cylinder 13 ft. high and 7 ft. in diameter. It holds two people, the equipment needed to keep them alive, flight instruments and controls, and experimental instrumentation.

This gondola was originally designed as a platform for a high-altitude escape program (for Project *Mercury*). It was never used for this purpose, and modifications for *Star Gazer* were begun in 1958.

In flight, the gondola will be pressurized to an altitude of 22,000 ft. The occupants will wear partial pressure suits and helmets with the face plates open.

Launching will be done with the aid of a Le Tourneau Log Loader, a commercial vehicle usually used for the indicated purpose. A bubble in the balloon is first inflated with sufficient helium to take the aerostat to altitude, and then the balloon is released. Meanwhile, the Log Loader is holding on to the gondola by a shank of supporting ropes.

When the balloon is vertically above the gondola, which can be assured by proper jockeying of the Log Loader machine, the aerostat is released. Advantage of this method is that launching does not require a perfectly calm day but can be performed in winds up to 10 mph.

• **Flight plan**—Following take-off in the evening near Chico, Calif., the balloon will be at ceiling altitude of about 87,000 ft. approximately 100 minutes later. The telescope stabilization system will then be turned on and observations will start.

At about midnight the same day, the balloon will start down. Observations will be made during descent.

Attempts will be made to get scintillation and water vapor data. It may not be possible to measure actual amounts of upper-atmosphere water vapor, but it will be possible to plot a relative curve showing the loss of light in certain wavelengths due to increased water vapor during the descent from the atmosphere. The landing will be made at sunrise. ⌗

Members Expected To Merge AIEE and IRE

Cautious optimism over consolidation voiced at meeting of Institute; highlight is report on gigacycle computer work

by Mike Getler

NEW YORK—A merger of the American Institute of Electrical Engineers and the Institute of Radio Engineers now appears likely.

A membership vote on the merger, conducted concurrently by both organizations, is expected by mid-June, following scheduled release in March of a report by a joint committee of top AIEE and IRE officials. The committee has been studying the "feasibility, practicability, and form of consolidation" since last October, and its report is expected to favor a mutually agreeable merger.

Several joint two-man study groups are also at work on financial, legal, and geographical problems posed by such a consolidation of the 70,000-member AIEE and the 90,000-member IRE.

These problems were given an airing last week at AIEE's winter meeting here.

Officials of both organizations, though generally optimistic, are hedging on the predicted outcome of the membership vote. They point out that while optimism may run high at regional or seasonal technical sessions, the bulk of the membership is of the stay-at-home variety and has never actually been polled on the question.

Whatever the outcome of the vote, no merger action will be taken until after the first of the year.

• **Some doubts**—AIEE observers at the meeting here reported that some factional doubts concerning the benefits of a merger had been voiced by members of the heavy power plant and cable industry, who probably have least to gain from the radio engineers' meetings.

The future of the AIEE exposition-type meeting, which was tried for the first time here last week, was also discussed. Some members speculated that even if the two groups joined forces a modified version of the AIEE meeting and technical display would continue on an annual or biannual basis, aimed primarily at the power and electromechanical industries.

The likelihood of the merger, coming on the heels of a probable combination of the American Rocket Society and the Institute of the Aerospace Sciences (M/R, Jan. 22, p. 9), could set off a wave of technical-society mergers in other fields where there is considerable overlap of membership and technical presentation. Approval of both the AIEE-IRE and ARS-IAS mergers could, by 1963, put almost 200,000 scientists and engineers engaged directly or indirectly in aerospace efforts in either of two extremely powerful technical bodies.

• **Technical highlight**—On the technical side of the New York meeting, the rapid expansion of high-speed computer technology was very much in evidence.

Eight technical sessions covering 31 papers were presented in this area. Four of the sessions dealt specifically with future computer operations in the gigacycle range. The papers and discussions were the first public disclosure by the AIEE of work in this field, and are an outgrowth of a recent closed workshop on the subject held by the organization's Computer Systems Subcommittee in Carmel, Calif., last May.

A gigacycle, or kilomegacycle, computer would reportedly operate at speeds 1000 times as fast as current 1-5 megacycle units, with memory access times between 10 and 40 nanoseconds and gate delays on the order of a fraction of a nanosecond.

Application to problems of voice recognition, spatial pattern recognition, lengthy partial differential equations, and solution of game theories with incomplete strategics were described. Gerhard L. Hollander, director of Hollander Associates, a Fullerton, Calif., computer consulting firm, predicted that within two or three years early gigacycle computers would be handling problems now being tackled by existing computers operating in parallel.

• **Economy studied** — Hollander placed heavy emphasis on the economic aspects of introducing such high-speed computers, claiming an eventual low operating cost in terms of load per computer dollars—and high reliability through use of smaller and fewer components.

According to Hollander, the very short distances which electrical energy can move during a nanosecond will necessitate very small and compact packaging for these devices. Carrying this thought further, he hinted at widespread space applications made possible by microminiaturization in computer manufacture.

Several companies—including RCA, Sperry Rand, IBM, Philco and General Electric—are working to develop gigacycle computers through many avenues.

RCA, proceeding under a Navy Bureau of Ships contract, Project *Lightning*, is reported to be about two years away from first laboratory trials of a device based on tunnel diode technology. As of now, this is expected to be the first operational computer capable of gigacycle speeds.

Use of extremely thin films operating under cryogenic temperatures is also considered a likely approach to gigacycle development, and is viewed by Hollander as having even greater economy.

Current thin-film "cryotrons" are said to have switching capabilities on the order of one two-hundred-millionth of a second. Improved thin films, reduced in thickness to about one fifty-thousandth of an inch, were credited with speed capabilities of up to one ten-billionth of a second. ⌘

ARS-IAS Merger Study Report Due in May

A TEN-MAN consolidation steering committee composed of representatives of the American Rocket Society and the Institute of the Aerospace Sciences is due to submit a final study report on the proposed merger of the two societies in May.

At that time, both groups will make independent decisions on submission of a specific consolidation plan to be voted upon by members.

Action this year doubtful . . .

Congress Awaits JFK Lead on Patents

Hearings held on bill to liberalize NASA rules, but Administration wants uniform policy

by Charles Schaeffer

AFTER A NEW ROUND of hearings on the controversial issue of liberalizing the patent provisions governing NASA's research and development contracts, Congress this week was still looking to the White House for the next move.

This could come, perhaps within six weeks, in the form of a broader proposal—not limited to NASA but applying uniformly to other government agencies. What exact form the long-in-the-making policy would take, government witnesses were not prepared to say as they readied testimony for a special Patents Subcommittee of the House Science and Astronautics Committee.

Under consideration at last week's hearings was legislation (H.R. 1934) by Subcommittee Chairman Emilio Daddario (D-Conn.) to give the NASA Administrator more flexibility to waive claim to titles of inventions developed under space agency contracts.

Essentially, the bill preserves the government's right to an irrevocable, non-exclusive, nontransferrable royalty-free license, along the lines of the present Defense Department administrative rule. As a safeguard, NASA could retain title in the "national interest" or when a higher law prevails.

Despite conflicting views, Rep. Daddario told MISSILES & ROCKETS, he believes the subcommittee will recommend liberalization to the full committee. The bill's fate then depends on:

—Whether Congress chooses to consider the Administration's upcoming uniform government policy instead of the parochial NASA issue.

—Whether Congress overrides NASA's reluctance and gives the agency the liberalized waiver rights it no longer is seeking.

—Or whether Congress simply does nothing.

In an election year, with congressmen facing showdown floor fights on many other controversial issues, the latter now seems the likely choice. And one subcommittee member, Rep. Edgar Chenoweth (R-Colo.), candidly sees scant prospect for obtaining a uniform patent policy in a Congress divided over the issue of whether contractors or the government should own inventions developed under Federal contracts.

Against this backdrop, the Justice Department posted an objection to the bill on the grounds that government research contracts to the largest firms are already "contributing a powerful impetus toward a concentration of industry that is antithetical to the basic principles of a free enterprise system." Moreover, wrote Byron R. White, Deputy Attorney General, "grants to a private contractor of patent rights on the research so financed perpetuate for a considerable period the advantage over competitors . . ."

Enactment of the bill, White contended, would prejudice the case for a reasonably uniform government policy by establishing for a single agency "a new basic policy substantially differing from that embodied in any previous legislation on the subject."

In Justice's view, White wrote, "the bill would also eliminate the present requirement for reporting all technical information developed under contract, thus encouraging accumulation of know-how in the hands of favored contractors to the exclusion of competitors, frustrating diffusion of technical and scientific knowledge involved even for the Government's own use in further research and development of related production." Subsequently, Justice officials were asked to amplify their views in public testimony.

In contrast, the Defense Department last summer supported Daddario's effort to liberalize the law. Commenting on the Department's views filed with the committee, Daddario said: "The Defense Department believes that a flexible licensing policy on patents and inventions by private contractors is in the best interest of the country and also applies to the National Aeronautics and Space Administration."

Last week, as the hearings moved to a climax, NASA witnesses were scheduled to brief the subcommittee on recent administration of the agency's patent provisions. And they were ready to report no change in the position taken last May. In essence, this is that the present law is causing no serious administrative problems.

Within the Commerce Department's patent office, the situation, as officials prepared to testify, was this: a uniform policy is not yet "crystallized," but with pressure mounting within the Administration something should materialize within a month to six weeks. Meantime, Commerce is still fostering a middle-ground approach in an effort to appease the quarreling camps and to work out with industry and government acceptable protection for both.

The Daddario bill won support from two representatives of the missile propulsion industry.

"The public will realize optimum benefit from R&D expenditures of the U.S. Government if the license policies of the Department of Defense are encouraged and fostered," Emerson S. Reichard, Jr., Vice President-Administration, Aerojet-General Corp., testified. "This policy should be a uniform policy throughout the U.S. government and its agencies, and we advocate a clear expression of legislative intent in this regard by the adoption of specific legislation making such policies mandatory."

Franklin O. Davis, manager of the corporate patent department, Thiokol Chemical Corp., said the company believes the bill "will be helpful in reassuring smaller companies that they are not going to be put to too great a competitive disadvantage because they happened to have a government contract in a sensitive field." Reichard and Davis agreed that there is no general requirement for the government to take title to inventions while it has the protection of the royalty-free license. ⌘

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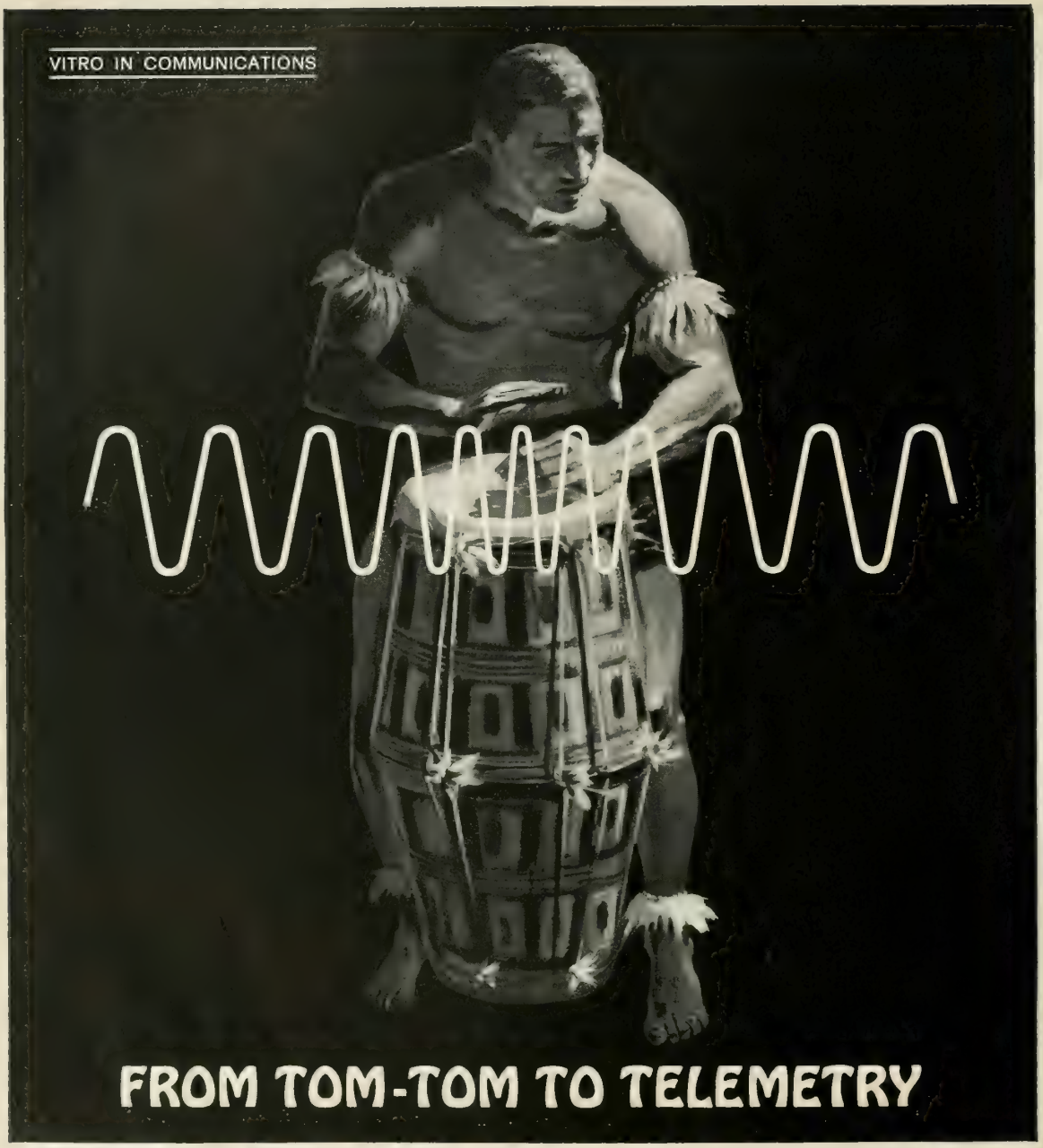

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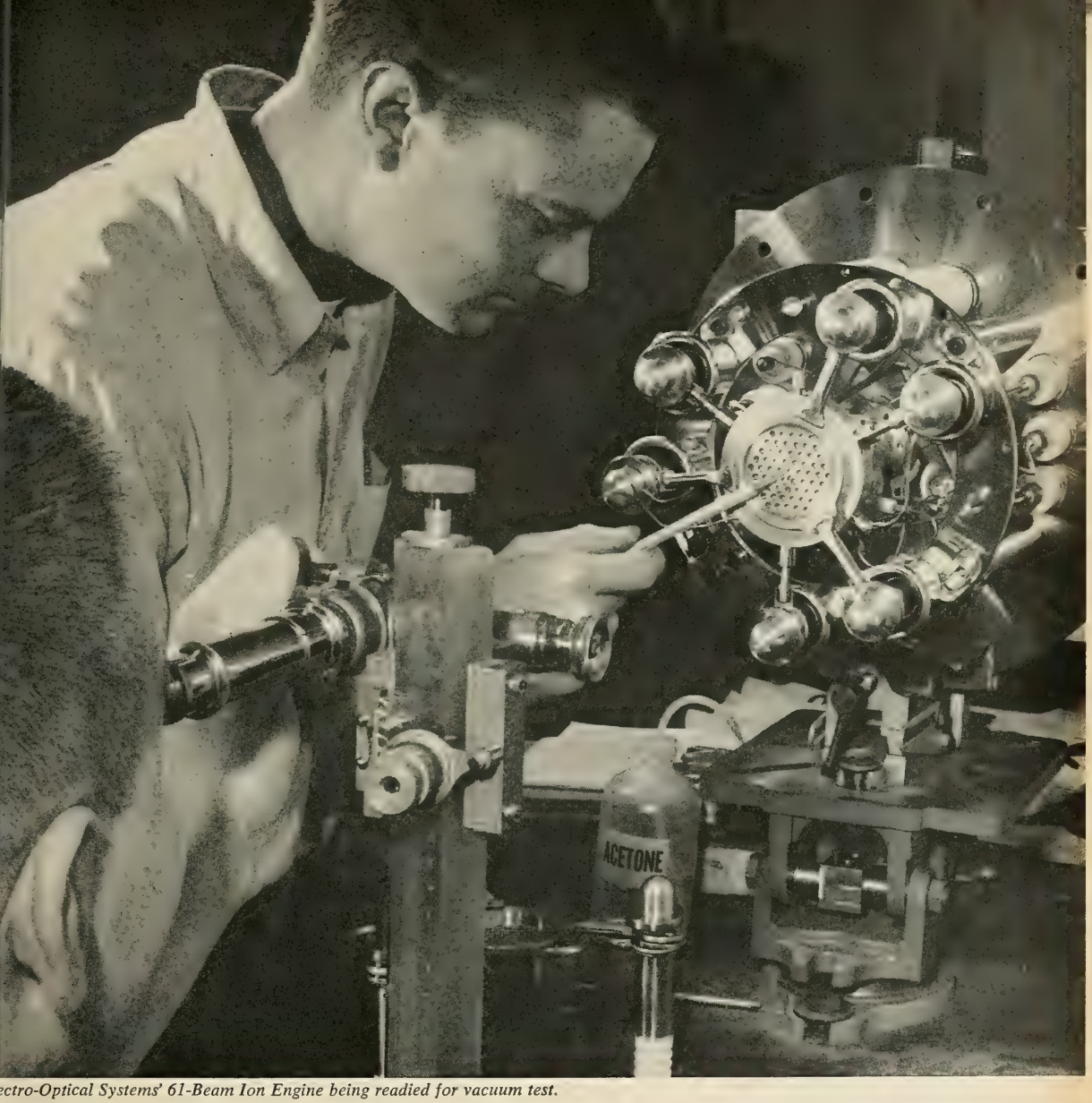


ectro-Optical Systems' 61-Beam Ion Engine being readied for vacuum test.

SPECIAL REPORT

ELECTRICAL PROPULSION: HOW SOON?

Electrical engines are essential to the intelligent development of observation and communications satellites — and they will become available sooner than many people think. The following special report compiled by M/R Associate Editor John F. Judge shows where we stand today in power transmission . . . engine technology . . . and why we hope to hit operational target dates in the near future.

Electric Engines At Stage of

Developments indicate early space propulsion devices can pay off in some areas; data-gathering, communications cited

IF THE U.S. is to have operational electrical propulsion systems in the 1965-67 period, lead-time considerations dictate an immediate move into full-scale programs and adequate funding in the very near future.

Experts in the field agree that it takes a minimum of 18 months to design, build, environmentally test and integrate an electrical propulsion engine into an operational system.

Electrical propulsion engines are rapidly approaching the mission requirement stage. No longer considered "exotic," some of these devices have been pushed by fast-paced development programs into the flight-test regime.

The National Aeronautics and Space Administration plans to start short-duration test flights with ion engines in the fall of 1962. Arc-jet engines will join the test program early in 1963, and short-duration tests of plasma devices in space are slated for 1964.

All tests will probably involve *Scout* vehicles and ballistic trajectories.

There is a definite possibility an orbital life test will take place in 1964, involving all three propulsion concepts and a larger booster.

I. R. Schwartz, chief, NASA Electrical Propulsion Office, says the lead time is running out. "We should start moving now on a large scale; merely discussing the potential of electrical propulsion is not enough."

The NASA space propulsion effort is aimed at handling any mission profile that might appear. The present emphasis on booster development has all but obscured many concurrent space technology requirements and several of these are particularly suited to electrical propulsion.

For instance, a fantastic amount of data are needed to support currently funded programs. This is the run-of-the-mill information—radiation, meteroids, magnetic fields—so vital to intelligent design. The precise, methodical and efficient investigation of near-earth space can be handled only by electrically propelled vehicles.

• **Years of operation** — The long-duration propulsive characteristics of electrical engines make a probe capable of accurately collecting a vast amount of information while canvassing a huge segment of near-earth space. A gradually widening spiral orbit is one example.

Communications satellites generate another set of requirements best handled by the devices. The 1-KW arc-jet now nearing test flight could be utilized for attitude control with a lifetime far surpassing a chemical system.

There are many other missions in the lower power levels that can be efficiently and economically handled with first-generation electrical engines.

The ultimate use of these engines will be in deep-space missions. A great deal has been said about their capabilities here. But some of these engines can be pulling their weight before the average American has paid for his 1962 car.

• **Concept breakdown** — There are three basic electrical propulsion devices —electrothermal or arc-jet, electrostatic or ion, and electromagnetic or plasma.

The arc-jet provides thrust by heating a gaseous propellant with an electric arc. The propellant, at several thousand degrees F, is expanded through a conventional nozzle. Specific impulse runs from 700 to 2000 sec., and the thrust in operational engines will be between 0.01 and 1.0 lbs. Although low in I_{sp}, the arc jet is the simplest device capable of generating high thrust from a given amount of power. This is due to its low power and energy transfer losses.

A 1-KW arc-jet being developed by Plasmadyne Corp. may find applications as an attitude-control system in communications satellites. The NASA-funded project is now at a design requirement stage.

Electrostatic or ion rockets create thrust by accelerating charged particles. A propellant, usually cesium, is vaporized and impinged on a heated tungsten emitter. Positive cesium ions are generated, then accelerated through electrostatic fields and ejected, providing thrust.

Ion rockets have theoretical I_{sp} ranges between 3500 and over 10,000 sec. with thrusts of 0.01 to 0.5 lbs.

Since the propellant is positively charged, an ion device must be neutralized or a negative charge will build up on the vehicle. If this happens, the ion beams will be drawn to the vehicle—effectively destroying thrust. Developers of the various ion devices have solved this problem.

The electromagnetic engine operates by accelerating plasma—a gaseous mixture dissociated and ionized into approximately equal amounts of electrons and positively charged ions. The mixture, sometimes called the fourth state of matter, does not behave like a normal gas in the electrical sense. Although neutral, the gas responds to electrical and magnetic fields.

Acceleration is achieved by applying mutually perpendicular magnetic and electric fields. This brings the synchronous motor principle into the picture—when a conductor is acted upon by mutually perpendicular magnetic and electric fields, it moves.

Plasma engines have a potential I_{sp} range from 700 to over 10,000 sec., with thrusts between 0.01 and 1.0 lbs. Current development programs are pri-

Operational System Planning

by John F. Judge

marily aimed at the I_{sp} range between arc-jets and ion engines, although there is an overlap at either end.

These engine concepts do not compete with each other. There are definite flight profiles best suited to one or another of these devices. In first-generation engines there may be overlapping missions; the choice will then depend on such familiar criteria as reliability, efficiency and economy.

For long deep-space missions, the ion engine seems to be the logical system. As the mission time is reduced, plasma devices may offer more in terms of meeting mission requirements.

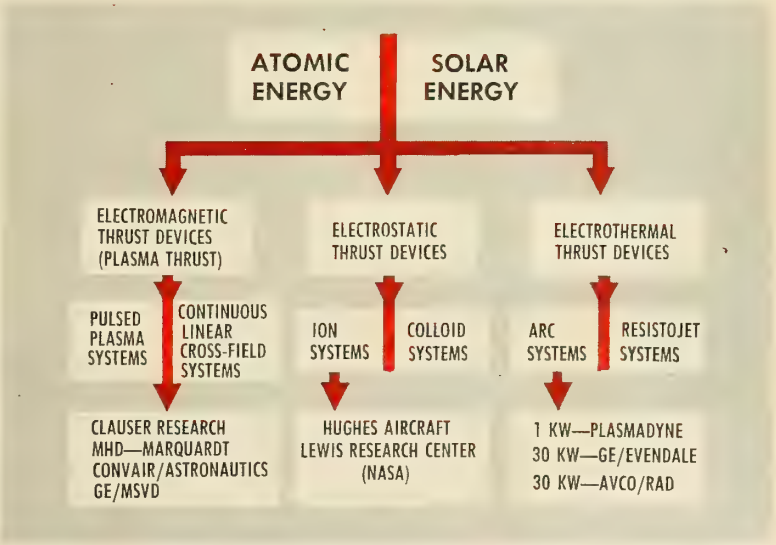
It is likely that the arc-jet will be the first operational system. It is even more likely that it will be combined with one of the other concepts for specific space tasks.

Electrical propulsion has lost much of its aura of mystery. The hard, realistic standards commonly applied to chemical propulsion systems must be met.

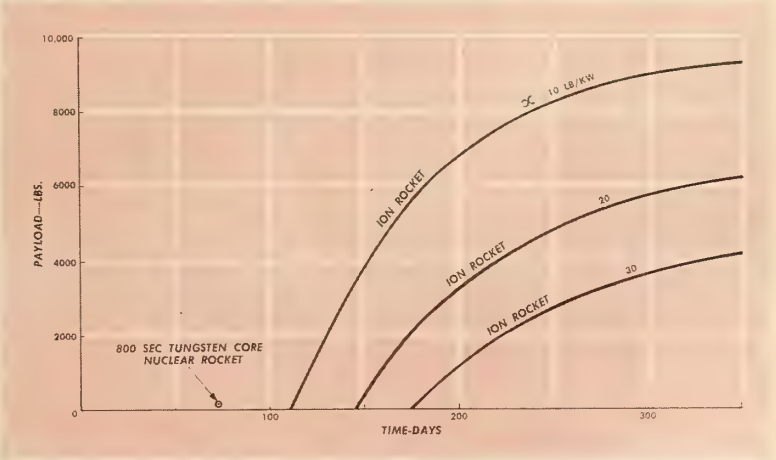
• **Electrical economics** — The advantages of electrical systems over chemical propulsion are well known. The ratio of payload to propellant weight in electric devices far surpasses anything in the chemical area. For instance, considering comparable overall booster system, an ion rocket upper stage can place 4840 lbs. in a 24-hr. orbit, while a chemical engine payload could not exceed 2360 lbs.

NASA electrical experts constantly emphasize the flight regime—electrical devices are space engines. These devices cannot function unless they are free from the restraints of a planet. The natural environment for these units is space.

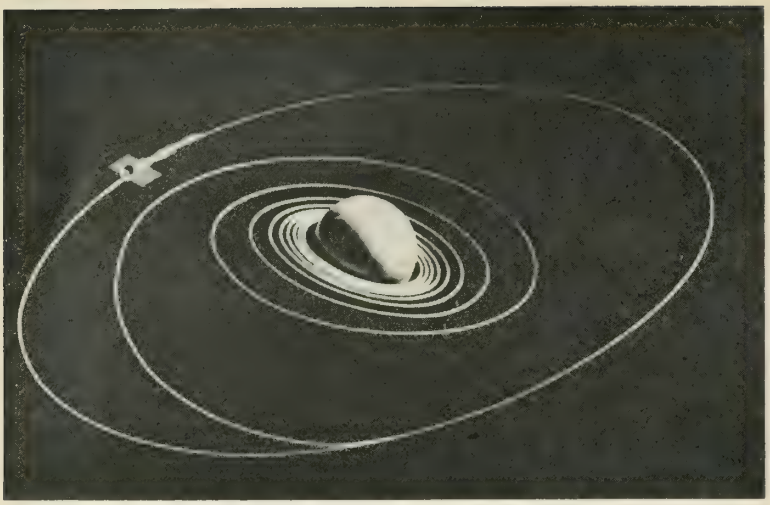
NASA's planned funding for electric propulsion in Fiscal 1963 is $30,-



ELECTRICAL PROPULSION breaks down into three main concepts, illustrated with some engine contracts. Power in early flights can be either nuclear or solar.



SOLAR PROBE to 20 solar radii mission using Saturn C-1 launch vehicle is one instance in which even the nuclear rocket is outclassed by electrical engines.



24-HOUR SATELLITE ORBIT spirally reached with electrical propulsion. Same spiral concept can be used for accurate and wide-ranging data-gathering.

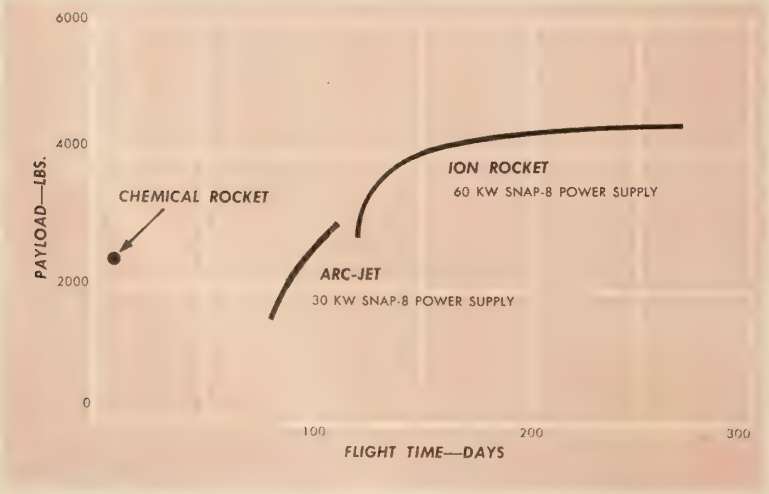
647,000. Of this amount, approximately $10 million will go for power source development for electric propulsion systems. Space power sources receive funding from other areas of the NASA budget, making the total figure somewhat higher. But power is the limiting and pacing item in the use of electrical propulsion.

Sunflower and SNAP 2 (see page 33) are the candidates for the first-generation electric engines. The next step in power generation will come with the 30-to-60-KW SNAP 8 systems. The ultimate is in the megawatt ranges. When these levels are reached, electrical propulsion systems will be pushing manned and unmanned payloads towards the distant planets.

But these systems are still far in the future. The relatively low power sources of 3-30-60-KW capacity will soon be available in terms of mission lead time. If electrical propulsion systems are given the necessary attention, by the time the large boosters are ready the U.S. will have a space propulsion capability far in excess of anything in the current technology. And this, says NASA scientists, is the 1965-67 period.

There is still a fair share of problems associated with the ion and plasma engines. In terms of development, the ion devices are more advanced than plasma. But, for several reasons, plasma engines are proving more and more attractive in terms of potential. Their developed thrust is higher, and rewards may be realized in simplicity of configuration. In some cases, there is a scale-up factor that takes advantage of megawatt power ranges to a greater degree than the ion device.

All of these are unrealized benefits.



EQUATORIAL SATELLITE mission (24-hr.) illustrates the relative capabilities of electrical systems as compared to a chemical approach.

At the moment, ion engines are likely to capture and maintain superiority in certain flight profiles.

• **Ion engine problems**—The main headache area centers around the electrode. In the electron-bombardment device, electron emitter life is being extended through use of a low-work-function emitter. Propellant utilization efficiency increases are under investigation.

Contact ion devices pose their principal problem in the area of increasing the current density from the emitter. Accelerate-decelerate configurations are being used to handle this. A secondary problem is the reduction of the impingement of ions on the accelerating electrodes.

Hughes Aircraft Co. is reducing electrode interception of ions through computer techniques in ion optics. Neutralization is not considered a major problem by any of the ion engine firms —but most agree that flight tests are necessary for absolute proof.

In colloidal particle rockets, the main problem seems to be the establishment of uniform charges on the particles—and the measurement of these charges. NASA-Lewis is investigating an experimental quadrupole mass spectrometer to measure the charge/mass distributions in the beam.

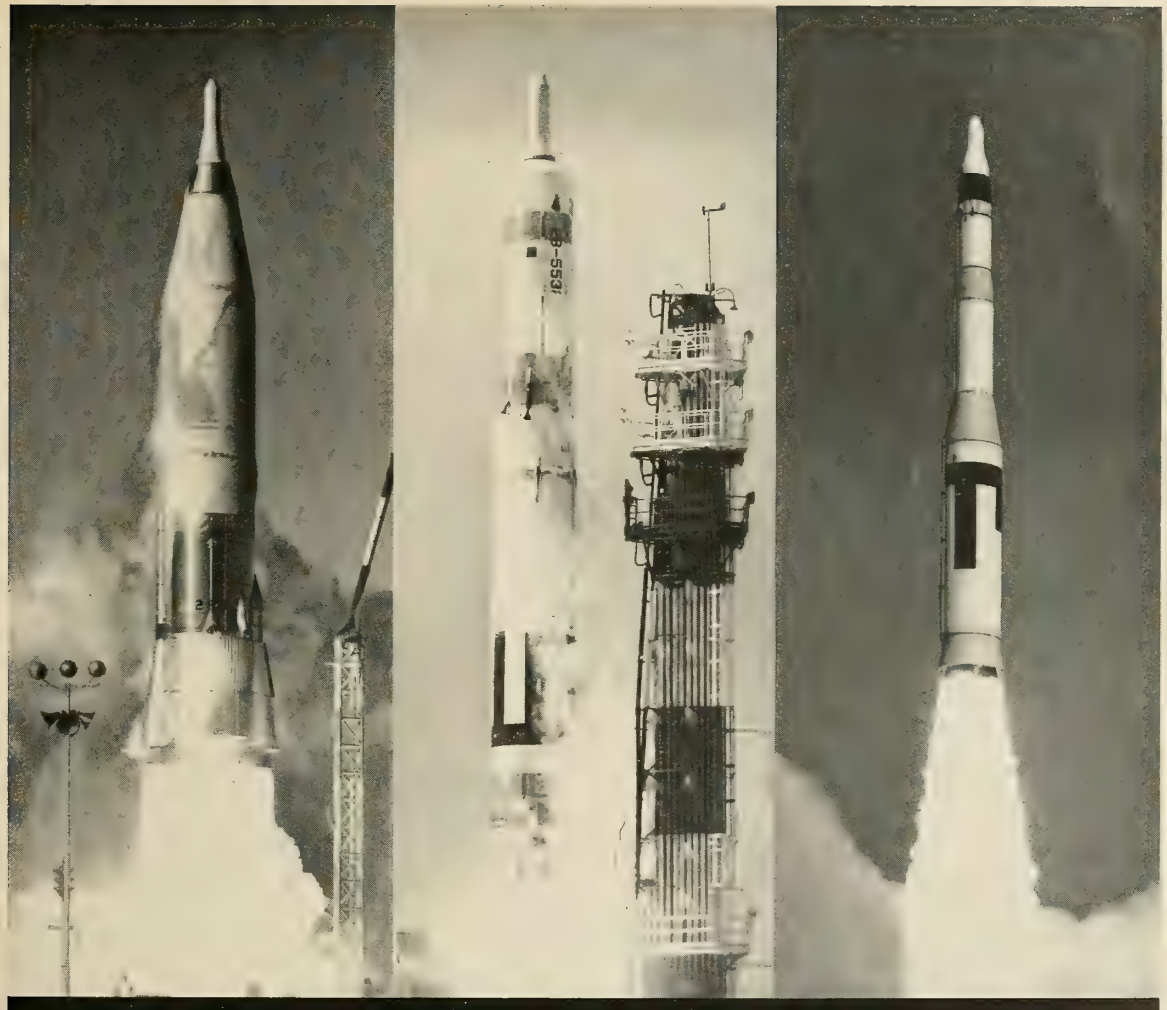
Traveling wave plasma engines pose problems in the mechanism of coupling between gaseous conductors and the traveling magnetic wave. Actual performance and scaling laws provide more complexity to the overall area.

There are also problems in magnetic insulation, and in achieving desired repetition rates. Cross-field plasma accelerators have problems—in material limitations and steadiness of the discharge in the high magnetic fields .

• **Unfounded optimism** — One of the side-effects of ion engine development has been a sudden surge of interest in the manufacture of cesium, currently the most applicable propellant. There have been gold-plated predictions of large-quantity consumption of the metal in relation to projected electrical propulsion demands.

Prior to 1950, cesium was purchased in 5-to-10-gram quantities by a very few people. It was only in 1959 that the metal began to move in 1-lb. lots, and the entire output of cesium used currently is measured in the low hundreds.

Reports of a boom in the metal have been a bit optimistic, one major supplier says. Before these figures can be realized, space applications of the metal will have to be a common thing—something not likely to occur in this decade. A pound of cesium goes a long way in an ion engine. ⌘



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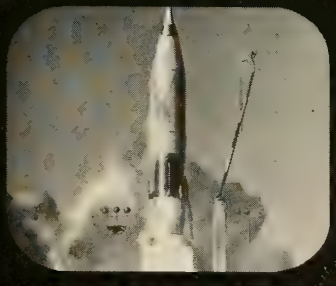
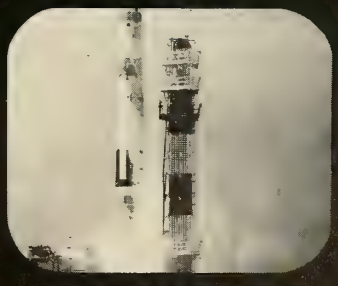
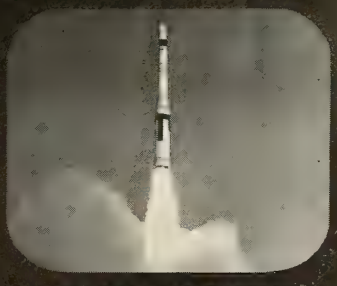


1. The Atlas at Vandenburg Air Force Base.



2. The Titan at Vandenburg Air Force Base.



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Diverse Programs Push U.S. Art

RESEARCH, development and hardware programs in electrical propulsion are shifting into high gear at various laboratories across the country. Industry, NASA and military specialists are developing engines on a broad front with varying degrees of success. Security restrictions and proprietary considerations preclude a complete resumé of electrical propulsion work in the U.S., but the following summary represents, in a general manner, the diversity and status of the various projects in this major field.

ALLISON DIVISION, GENERAL MOTORS CORP.—Two engines and studies into beam-charge neutralization are in the works. Both engines are plasma. One is a fast-pulse, fed-wire-propellant, rail-type plasma accelerator. Its single-pulse I_{sp} is currently in the 2000-7000 sec. range with a 38% efficiency. The units is expected to reach an efficiency of 50% at an I_{sp} of 4000 sec. using 30 to 60 KW power sources.

The second engine is a fast-pulse, gas-injection annular magnetic shock accelerator with a current low-pulse I_{sp} of 2000-6000 sec. and an efficiency of 20%. By 1965, this unit is expected to have a 50% efficiency at an I_{sp} of 4000 sec., using 30 to 60 KW power sources. This development is funded by both GM and AFSC-ASD.

AVCO - EVERETT RESEARCH LABORATORY—A steady-state magnetic annular-arc engine (MHD rotational device related to both the arc jet and crossed field accelerator) is being developed under AFOSR sponsorship. The unit has achieved 0.75-lbs. thrust, I_{sp} of 400 sec., but is expected to ultimately reach thrust above 1 lb. with an I_{sp} between 1000 and 2500 sec. Overall efficiency is 15-50%. Argon has been used, but lithium may be best.

A pulsed coaxial plasma accelerator with an expected operating I_{sp} range above 2000 sec. is also under development. Thrust and efficiency have not yet been measured but the I_{sp} presently falls between 2000 and 20,000 sec.

A C.W. traveling wave plasma accelerator (EM region magnetic channeling) is the third device being studied. Its current thrust is 1/20 lb. with an I_{sp} of 2500 sec. and an efficiency level of 30%.

The fourth device is a d-c steady-state plasma accelerator (EM region magnetic channeling) with an expected operating range similar to the last two. Thrust, I_{sp} and overall efficiency have not yet been measured.

All units are under AFOSR funding.

THE BOEING CO.—Two company-funded studies are under way—one of a magnetic induction plasma engine, the other of a pulsed-plasma rail accelerator. Thrust, I_{sp} and efficiency values for the first have not yet been measured, while the second has a present thrust of 0.003 lbs., I_{sp} of 5000 sec. and undetermined efficiency. The magnetic induction unit is expected to develop into a 1-lb.-thrust device with I_{sp} levels between 2000 and 10,000 sec. The expected thrust-to-weight ratio is 10^{-4}, the same as the parallel rail unit.

CLAUSER TECHNOLOGY CORP.—The firm is engaged in research and development of an electrodeless plasma propulsion engine for NASA. The pulsed plasma device uses a traveling magnetic field method to accelerate hydrogen to velocities in the 10^5 meter/sec. range. A magnetic field is made to move along an accelerator tube containing the plasma.

Thrust is not readily measurable but a net impulse of 1.2×10^{-3} kg m/sec. has been determined at an I_{sp} of 5000 sec. At a repetition rate of 10 KC this would correspond to a thrust of 2.5 lbs. No efficiency figures are available yet.

ELECTRO-OPTICAL SYSTEMS, INC.—A multi-beam-contact cesium ion engine is being developed under an AFSC-ASD contract. The prototype 61-beam units have developed 3.2 millipounds thrust, 5000 to 8000 I_{sp} ranges and efficiences up to 65%. Engines have been continuously run over 175 hours and power-to-thrust ratios were in the 280-kw/lb. range last May. The firm has performed on 14 contracts in the ion propulsion field; 11 of these are still active or being expanded.

The multi-beam engine configuration is based on circular porous tungsten ionizers mounted in closely packed hexagonal arrays. The accelerating and decelerating electrodes have corresponding multiple circular apertures. The porous ionizers are back-fed from a cesium vapor supply system controlled by a needle valve.

GENERAL DYNAMICS/ASTRONAUTICS—A coaxial, pulsed-plasma gun is being studied under a feasibility contract from NASA. The unit consists of two cylindrical electrodes which accelerate small amounts of repetitively introduced gases to provide thrust. Propellants to be investigated include hydrogen, helium, argon and nitrogen.

GENERAL ELECTRIC, MISSILES AND SPACE VEHICLE DEPT.—There are development programs in arc jet and ion engines under NASA and Air Force funding. The arc jet, using hydrogen propellant, has a current thrust of 0.5 lbs., an I_{sp} of 1000 sec. and an efficiency of 38%.

The ion engine has a current thrust of 0.005 lbs., I_{sp} of 8000 sec. and a 26% efficiency. By 1965, the unit is expected to have an I_{sp} of 5000 sec. with an efficiency of 55%.

MSVD also has study contracts from NASA and DOD into the following areas: A microwave B field accelerator (Cyclops) under NASA which calls for a flyable prototype by the end of 1963. A two-stage coaxial pulsed-

plasma accelerator (REPPAC III), a single-stage coaxial accelerator (REPPAC II) and a stationary inductive device are being studied under GE/DOD funding.

The microwave accelerator is an inductive type involving electron cyclotron heating and plasma acceleration by a magnetic nozzle. The motor is driven by an intense beam of kilomegacycle RF power which breaks down gas introduced slowly to the propulsion chamber. The entire system is immersed in a steady magnetic field. The axial or Bz component of the field is tuned so that the electron cyclotron frequency resonates with the impressed RF field. This coupling results in a large power transfer to the ionized gas. The shape of the diverging magnetic field deflects the motion of the electrons from spiraling azimuthal orbits to translational thrust.

GOODRICH-HIGH VOLTAGE ASTRONAUTICS, INC—A high-current- density, arc-type, heavy ion engine is being developed under AFSC-ASD sponsorship. The arc section is comparable to duoplasmation-type source geometry, but performance and specifications are currently classified and proprietary. The firm has a NASA contract for a low-current-density electron bombardment engine which works on mercury propellant. The unit is similar to configuration under study at Lewis. It uses honeycomb acceleration electrodes with a thrust level of more than 5 millipounds.

Experiments are designed to clarify the plasma physics of the source and learn more about sealing relations as well as the unit's current density potential.

The firm also supports work into heavy particle (colloid) production schemes for thrust applications—mercury colloids as well as sub-micron-size conducting powders are involved. The research is devoted to accomplishing sufficiently large specific charges on the various colloidal fuels under consideration, and to permitting useful specific impulses in the exhaust at acceleration voltages less than 1 million volts.

HUGHES AIRCRAFT CO.—The major device in the works here is an ion engine, although the firm is also in research programs on several plasma type approaches. The ion engine uses an annular-beam configuration and prototypes built to date have reached the several-millipound thrust level. The NASA sponsored development work on larger-thrust units is proceeding, but details are not available.

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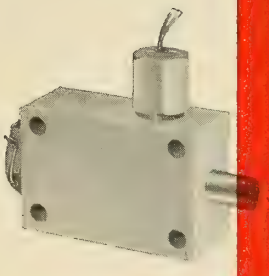

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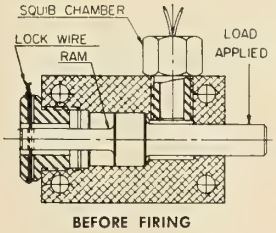

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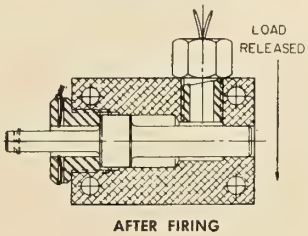

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ing studies and developing hardware for an ion engine designed for 62 millipounds thrust per square foot of engine frontal area operating with net acceleration voltages of 5000 volts.

The unit consists of parallel, cylindrical segments, reverse propellant feed and a solid tungsten ionizer surface with cesium propellant. The engine can be any size from 0.003 sq. ft. up, with no change in basic structure or design.

Present laboratory performance is 50% of the design thrust, using a 0.013-sq.-ft. motor.

MARQUARDT CORP.-MHD RESEARCH, INC.—A team effort sponsored by NASA is investigating the feasibility of a continuous-current, crossed-field plasma accelerator. The engine can be functionally described as a discharge between electrodes, with a magnetic field applied at right angles. Motor forces accelerate the gas.

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION, LEWIS RESEARCH CENTER—Eight engines are currently in various stages of research and development at the space agency's electric propulsion center.

• Electron Bombardment Ion Rockets (Kaufman engine): The device consists of an ionization chamber containing an electron emitter wire and outer cylindrical anode—with external coil to produce a weak magnetic field in the chamber. The accelerator electrode is a perforated disc and neutralization is achieved through an electron-emitter wire in the downstream ion beam.

The propellant is mercury, and 1-3 KW power levels are under intensive investigation for flight-testing. Ion beam currents up to 1 amp. have been generated. 10 KW to 30 KW clusters are being designed for study in a large-vacuum test facility. Thrust levels range from 0.007 to 0.2 lbs. at an I_{sp} of 5000 sec.

• Contact Ion Rockets (Porous Tungsten Emitter): The unit's configuration consists of a slab beam using a porous tungsten emitter 0.3 by 6 in., radiation heated by a tantalum filament. The element gives a beam power around 300 W and a cluster of similar units is being fabricated to provide about 3 KW. The propellant is cesium.

• Contact Ion Rockets (Reverse Feed). A solid tungsten emitter is used with very closely spaced wire grids as accelerators. Neutral cesuim vapor is directed onto the downstream surface and ions are extracted through the grids. Power levels run less than 1 KW.

• Colloidal Particle Ion Rockets: Particles are generated during supersonic expansion of a low-pressure vapor.

ANNULAR-BEAM ion engine under development at Hughes will be one of first ion engine types flight-tested by NASA.

Subsequent charging and acceleration may use corona discharge with a conventional electrostatic lens. The propellants include mercurous chloride. Power levels are under 1 KW.

• Traveling Wave Plasma Engine: The configuration consists of a 4-coil, 1-wavelength length unit with the planes of the coil perpendicular to the accelerator axis. Current in each coil lags that of its upstream neighbor by 90°. Gaseous conductor supplied by electron bombardment source is accelerated by traveling magnetic field. Weak d-c axial field is used to partially confine the plasma.

The propellant is argon and power available is 26 KW at a frequency of 150 kc.

• Coaxial Pulsed Plasma Engine: There are two configurations under study. The first is a single-shot gun very much like the Marshall (LASL) gun. Gas metered by a fast-acting valve is admitted to annular volume through ports in the inner electrode. A condensor bank at 5000 joules discharges between inner and outer electrodes. The resulting current sheet is driven downstream by interaction between current and its self-induced azimuthal magnetic field.

The second configuration is a repetitively pulsed engine with a very low inductance capacitor integrally connected to a small gun. Discharge is self-initiated and the unit is operated with continual gas feed at rates of 100 to 500 per second.

• Electric Arc Jets: Three configurations are involved. Each has rotational symmetry about a central axis and each has the arc current passing between coaxial electrodes separated by an annular gap through which the propellant flows.

The specific geometries involved are 1) cylindical—the arc column is established in the subsonic region of a convergent-divergent nozzle, 2) constricted—the arc column terminates downstream of nozzle throat and 3) magnetically spun—similar to the first except the arc is rotated rapidly by an applied magnetic field.

• Resistance-Heated Hydrogen Jets: There are two configurations. Each has rotational symmetry and each heats the propellant by passing it through or over a resistance-heated, refractory-metal heat exchanger. The main difference between the two is in the heat exchanger configuration. One uses a thin tungsten tube, making it a low-voltage device, and the other uses tungsten filament wires, for high voltage.

The only possible propellant is hydrogen, since the desired I_{sp} is 1000 sec. Power levels are 1 to 30 KW.

PLASMADYNE CORP.—The firm is currently under contract in three major areas. A complete attitude control system is being developed for NASA, using a 1 KW plasma arc thruster. Part of this system will be flight-tested by the *SERT* program.

There is a 30-KW-thrust system in development, intended for use in a feasibility flight under Air Force sponsorship. The Air Force has also contracted with the firm for applied research into the MHD thrust field.

REPUBLIC AVIATION CORP.—A plasma-pinch engine with a thrust around 0.01 lbs. and an I_{sp} between 1000 and 7000 sec. is being developed under Air Force funding. The device consists of a nonconducting cylinder filled with gas. Each end houses a disc electrode. A potential across these electrodes generates a current sheath through the gas adjacent to the cylinder walls.

The magnetic field created by the current flow forces the sheath radially inward, compressing and heating the fluid. This pinching effect produces thrust when directed through a nozzle in the cylinder.

ROCKET RESEARCH CORP.—Three areas are being pursued with company funding. One program is in a low-power arc jet for satellite attitude control. The other two are low- and high-pulsed, confined-parallel-rail plasma accelerators. The lower pulsed unit is aimed at 10,000 hours operational life, 10^{-4} to 10^{-6} lb. thrust levels, 5000 sec. I_{sp} and efficiencies above 50%. The second pulsed device is being designed to 0.2 lb. thrust levels, similar I_{sp} and operational life ranges and an efficiency of 70% or better.

The first parallel rail device is for attitude control and the second is a primary propulsion engine. ⌗

Energy Transfer—A Standardless Task

Megawatt range places new and stringent demands on shaft horsepower conversion technology

by N. W. Bucci & R. W. Briggs*

CONVERTING shaft horsepower into electrical energy in a space environment is calling for exotic solutions to what have been standard problems.

The electromagnetic generator will take on a new shape—operating at high temperatures and speed, brushless and without rotating windings.

In a large space vehicle, electric-power generation is the primary power system. It provides propulsive power together with guidance, communications and utility systems power.

These requirements will probably fall in the 1-2 megawatt range and may rise as high as 10 megawatts. The extreme weight limitations make the design and selection of the electrical generator, its associated controls and conversion equipment a major undertaking. Some of the broad design prerequisites and suggested approaches are described in the following sections.

• **Generator considerations**—Since the power losses within the generator must be removed from the system by radiation, the system designer clearly desires a maximum generator operating temperature. The need for this can be illustrated by the Stefan-Boltzman radiation equation, which shows the thermal energy dissipated per unit area proportional to the fourth power of the absolute radiating temperature. Since the heat rejection area, and hence the radiator weight, decreases with operating temperature, a minimum weight power system is approached when the generator operating temperature is maximized.

An additional gain is realized in that reduction in heat rejection area also cuts the radiator meteoroid protection weight.

Increased generator operating temperatures lead to:

—Decreases in heat rejection radiator size and weight.

—A rise in electrical resistivity, causing a reduction in generator efficiency.

—Reductions in allowable rotor diameters resulting from reduced mechanical strength of rotor magnetic materials. The increased length-to-diameter ratio increases generator weight.

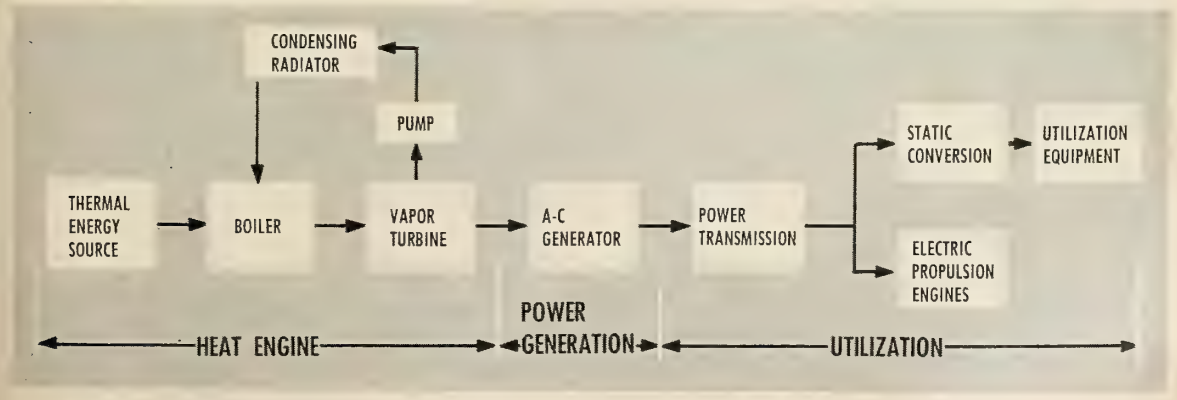
—Decreases in permeability of magnetic materials, resulting in increased generator weight.

—Increased magnetic material resistivity, resulting in reduced core loss and increased generator efficiency.

A second consideration is the generator operating speed. Minimum-weight rotating equipment, turbine and generator, generally results at maximum operating speeds. But rotational speed alone is not the only significant factor. The developed shaft power, or conversion efficiency, must also be taken into account in attempting to minimize the complete system weight.

Numerous studies have pointed out the need for evaluating the total power system performance as a result of variation in the major electrical system parameters such as speed, operating temperatures, and input power. For example, a minimum weight a-c generator will not, in many cases, result in a minimum weight conversion system—especially when turbine weight, generator heat-rejection radiator weight, thermodynamic cycle condensing radiator weight and nuclear energy source weight are combined with the generator weight.

• **Design selection**—The selection of the type of electro-magnetic generator is limited by virtue of the application requirements. The high operating speeds and temperature desired demand that the generator be brushless and contain no rotating windings. The elimination of brushes, commutators, and slip rings has been mandatory on



N. W. Bucci is Manager of the Systems and Analytical Section of Westinghouse Aero-Space Dept. R. W. Briggs is Systems Engineer in the same section.

high-performance aircraft, especially for high-altitude operation.

This requirement for brushless operation is more pronounced in space applications—where pressures of 10^{-4} to 10^{-6} mm Hg. will be encountered. Rotating windings have serious problems of high stress on conductors and insulation. Conductor creep results in large unbalanced forces landing to severe bearing loads.

Considerable design analysis of brushless, non-rotating winding-type generators have been completed, including the inductor, inductor-Lundell-inductor, Bekey-Robinson, and permanent magnet generators.

A-C generator weights in the range of 0.5 to 0.9 lbs/kv-amp are obtainable for space-power generators. This range of weight-to-rating ratio has grown out of numerous system design studies conducted by the Westinghouse Aero-Space Department.

• **Problem areas**—The main operational limitation of the inductor generator is the mechanical strength of the rotor magnetic material at the maximum desired speeds and temperature. As a general rule the electromagnetic weight of an a-c generator decreases with increase in speed until such factors as limited rotor diameters or poor armature slot combinations cause the weight to increase.

The Curie point of the magnetic materials, in addition to mechanical stresses, limits the maximum operating temperatures. The Curie point of cobalt irons, such as Westinghouse Hiperco 27, is in the range of 1700°F, and in the high-strength carbon steels, such as SAE 4340, is 1300°F. Thus the generator operating temperatures will be under the value for the steel used.

An alkali metal system-working fluid introduces a generator electrical insulation problem. Because of imperfect rotating seals, the interior of the a-c generator is exposed to metallic vapors. The insulation must either withstand the high-temperature environment and corrosive effects of the vapor, or be enclosed within a sealed arrangement such as a ceramic container.

The eddy currents (and hence power losses) within the generator air-gap region must be held to a minimum. Normally a vapor has a relatively low electrical conductivity unless the vapor is ionized by extremely high temperature or radiation. Once ionized, the vapor has an electrical conductivity that exceeds copper. Therefore, once the generator air-gap vapor ionizes, the induced losses increase significantly. This is readily concluded from previous rotating machinery evaluation.

The vapor ionization is affected by the particle bombardment resulting from radiation exposure. System design principles must prevent ionization from occurring with the generator.

• **Generator excitation & control**—The generator excitation system can be selected by considering the a-c generator and its method of excitation. The criteria for selecting an excitation system include:

—Minimum generator and excitation system weight.

—No equipment for generator overloads or faults.

—Minimum excitation system power loss.

—Solid-state rectifiers external to the a-c generator.

—Generator voltage control over the power factor and load range.

Generator excitation systems can be classified in two categories—static and rotary. Detailed studies and analyses have shown that the static exciter is more suitable for use with the inductor generator. The excitation power for an a-c generator, such as outlined above, is in the range of 0.5-1.0% of the generator rating.

With use of high-power semiconductors, a static excitation system can yield a minimum weight power system.

	Rotary Exciter	*Static Exciter*
Weight (lbs.)	32	12
Losses (watts)	1300	700
High-Temperature Losses	1100°	500°
Low-Temperature Losses	200°	200°

The high-temperature losses are within the a-c generator and would be rejected at temperatures corresponding to the generator coolant temperatures. The low-temperature losses are those resulting from solid-state devices and would be rejected at the temperatures corresponding to the limitation of semiconductors, for example 200°F.

Static excitation systems must supply generator field power in the order of 0.5-1.0% of the generator rating. For a 1-megawatt generator the excitation power is appoximately 10 kw. This represents a sizable amount of power to be handled by solid-state control devices.

Another area of consideration is the method and temperature of heat rejection. Semiconductors, as used in the static exciter, will not be capable of operating at generator temperatures.

At temperatures suitable for silicon rectifiers the heat rejection area and weight become large for any large amounts of power. Thus it is necessary to either minimize the power losses or develop high-temperature semiconductors for use in these applications.

Finally, the long-term damage and degradation of these components when exposed to radiation environments must be considered in designing solid-state control apparatus.

• **Power utilization**—The bulk of the power may be used by electric propulsion engines which require direct voltage levels in the range of 5000 to 50,000 volts or possible higher. The a-c generator output power must be rectified. Since there is a limit to the maximum alternating voltage that can be generated at the operating conditions being considered, step-up transformers and rectifiers must be employed.

The combined generator and transformer weight must be analyzed to determine possible trade-offs, to provide minimum system weight.

Undoubtedly, small amounts of power—10-20% of the generated power—will be required by guidance, communications, and utility loads. Since these loads are smaller than the propulsion engines, they should receive only secondary considerations in selecting the system operating parameters.

It may be necessary to incorporate static conversion units to supply the secondary loads.

The major problem associated with the power conversion and utilization equipment will be the operating temperatures and methods of heat removal. Of equal importance will be solid-state devices with power ratings suitable for these applications. Much development is required in the area of high-temperature semiconductors if static control and conversion devices in the range of hundreds of kilowatts are to be realized.

The final major component is the power transmission line. The conductors for carrying megawatts of electric power are considerable in size, especially for transmission distances in the order of 50-100 ft. The conductor spacing and operating frequency determine the system impedance.

Electric propulsion engines now being considered require d-c power; therefore, the generated frequency should be selected as the value resulting in minimum weight when considering generators, transformers, transmission lines, rectifiers and power system control. The increased frequency, while tending to reduce electromagnetic weights, increases the transmission line impedances. These impedances affect the generator size and the quality of power supplied by the electrical system. Operating temperatures and methods of removing the conductor losses must also be analyzed.

The problem areas associated with transmission lines do not appear to be as serious as those related to a-c generators and control apparatus. However, such questions as insulation, conductor flexibility, operating temperatures, power loss removal, and electrical performance must be considered. ⁂

First Systems May Use SNAP 2

SNAP 2, designed to continuously supply 3 KW for at least a year in space, is likely to be the first flying power source for electrical engines. The 1-KW arc-jet device is specifically tailored to such a power source.

A prototype of SNAP 2's reactor, called the SNAP Experimental Reactor (SER), was built by Atomics International Div., North American Aviation, and put into full-power operation in November, 1959. This effort set the stage for the start of last year's tests intended to couple the reactor heat to the power-conversion system.

Design and fabrication of SNAP-2 flight hardware is expected to take place during the current fiscal year. This will lead to a flight-test version which will be launched with the aid of the Air Force under the SNAPSHOT program.

Its energy source is a nuclear reactor, its converter a turbine-alternator, and the system operates in a Rankine cycle—the same as that of a steam-powered electric-generating plant on earth.

SNAP 2's design objectives are given by Atomics International as follows:

—Three-kw net electrical output.

—One-year automatic unattended operation in the space environment.

—System unshielded weight of 750 lbs.

—Automatic startup in space on ground command.

—A radioactive heat rejection area of 110 ft.

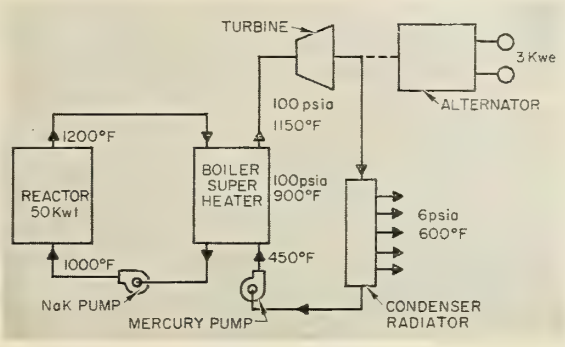
—Ability to withstand the launch environment of acceleration, vibration and shock.

—Thermal and mechanical compatibility with potential space vehicles and payload systems.

—Safe ground-handling and launching and a minimum radiation hazard to launch personnel and facilities.

• **How it works**—SNAP 2's nuclear reactor produces heat by the fissioning of U-235. A liquid metal (NaK) passes through the reactor's core, picks up about 50 kilowatts of thermal power, and flows out into a boiler superheater.

At the superheater, the NaK gives up some of its energy to mercury, which is the system's working fluid, and converts it into a gas. At the same time, NaK is pumped out of the superheater and back into the reactor for another cycle go-around.



SNAP 2 System

The superheater is a concentric tube, counterflow, once-through boiler. NaK flows in the annulus and mercury through the central tube.

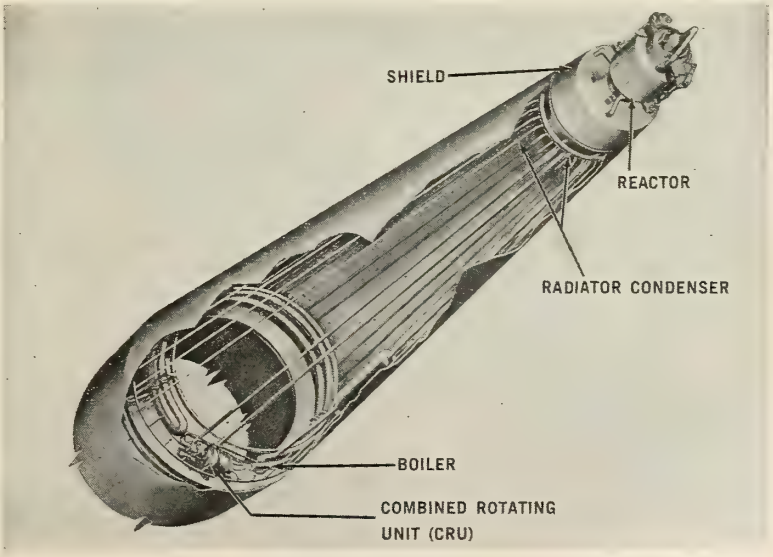
After leaving the superheater, the mercury is expanded through a two-stage impulse turbine. In turn, the turbine drives an alternator, which is a permanent-magnet machine with a sealed stator. The alternator delivers up to 3.5 kilowatts at 110 volts and 2000 cps.

Meanwhile, the mercury vapor passes to a condenser-radiator, which would probably form part of a spacecraft's outer skin. Here the vapor is condensed within a number of small-diameter parallel tubes which are in effect the skin's skeleton.

All rotating components in the power-conversion system are mounted on a common shaft, called the Combined Rotating Unit (CRU). This, the only moving part in the SNAP-2 system, is being developed by Thompson Ramo Wooldridge, Inc., under subcontract to Atomics International.

Rotating at 40,000 rpm, the shaft rides on mercury dynamic bearings. The entire rotating unit is enclosed in a hermetically sealed housing, thereby preventing loss of the mercury working fluid during the system's life.

The SNAPSHOT flight tests will end SNAP 2's basic development program. ⌗



Flight Configuration

Rails Proposed for Attitude Control

Experiments indicate pulsed plasma parallel-rail units may have higher efficiency and specific impulse

by Michel E. Maes
Research Engineer
Rocket Research Corp.

THE PULSED PLASMA accelerator—with experimental efficiencies in the 50% range and higher—may prove to be another contender for flying electrical engines.

In its simplest configuration, the accelerator consists of two parallel rails connected to either side of a capacitor. When the capacitor is charged one rail is at a high voltage with respect to the other, but no breakdown occurs when these rails are in a vacuum.

If a small amount of gas is admitted between the rails, it breaks down under the high voltage, permitting the energy stored in the capacitor to discharge across the rails.

When this happens, very high currents are built up, and the current configuration in the rails is such that a reinforced magnetic field is created between the rails and behind the plasma.

Since the magnetic field direction is perpendicular to the current direction in the plasma column, an accelerating force is generated which pushes the plasma down the rails. In the same manner, this magnetic field acts with the current in the back portion of the accelerator to produce a thrust on the accelerator.

The system produces thrust directly from electrical energy, using electromagnetic forces and a neutral plasma.

• **Mission studies** — The earliest space tasks best handled by a plasma accelerator probably will be satellite control missions. In view of this, Rocket Research analyzed thrust requirements for various satellite missions.

Perhaps the most concrete result of this analysis was that each specific mission requires a unique thrust level and operating mode. Certain general results, neverthless, can be applied to most satellite reaction control systems.

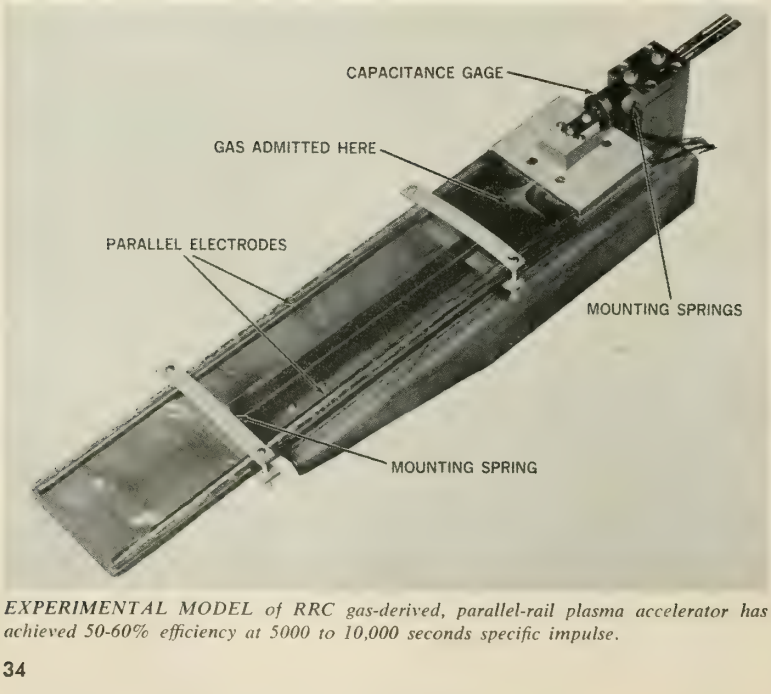
First, there are undesirable perturbations which, depending on the mission, will have to be overcome. Typical torques associated with these perturbations appear in Table I.

In addition to counteracting these, the attitude of a satellite must be adjusted or its orbit changed. Among the cases which RRC analyzed are the following: (1) A satellite looking at a point on the surface of the earth from a circular orbit, (2) a satellite looking at the center of the earth from an eccentric orbit, and (3) removing the eccentricity of an elliptic orbit. The thrust required to accomplish the above missions appear in Table II.

The minimum practical size of a chemical rocket is on the order of 1 x 10^{-2} lbs. thrust, because of injector size and operating efficiency problems. The firing duration is controlled by the opening and closing of the propellant valves; it is difficult to control the single-pulse impulse accurately for periods less than about 20 to 30 milliseconds.

Thus, for thrust levels below 10^{-4} lbs. it is advantageous to employ electric propulsion systems capable of producing thrusts of 10^{-6} lbs. or lower.

• **System weight**—Many of the new satellites, particularly reconnaissance and communication types, will have



EXPERIMENTAL MODEL of RRC gas-derived, parallel-rail plasma accelerator has achieved 50-60% efficiency at 5000 to 10,000 seconds specific impulse.

very long useful lives and require continuous orientation control for the full duration. A chemical rocket control system will consume much more propellant on such a mission than will an electric system, although the electric system will have a considerably greater inert parts weight.

Pulsed Plasma	Accelerator	Chemical
UNIT WEIGHT (DRY)	6.5 lbs.	2 lbs.
SPECIFIC IMPULSE	5000 sec.	300 sec.
TOTAL PROPELLANT CONSUMED	.6 lbs.	10 lbs.
TOTAL WEIGHT	7.1 lbs.	12 lbs.

The weight of the electric power supply was eliminated because in certain missions the nominal power required can be drawn from a power supply already on board. In some cases vehicle power is required for certain peak loads but would otherwise be available for attitude control. If this is not the case and power supply weight must be included, the pulsed plasma accelerator unit weight is raised to 33 lbs. (including a high-efficiency charger). Total operating-time crossover point as regards weight would then be about three years.

The preceding analysis shows that in certain cases—low thrust level or long operating times—the electric control system is more efficient than the chemical system. The only remaining question: Why the pulsed plasma accelerator instead of the ion rocket or the arc jet?

The attitude-control thrust requirement of most satellites varies considerably with time, and it has been found that a pulsed, limit-cycle control mode is an efficient technique for dealing with this variation. The ion rocket and arc jet are continuous-thrust devices; their thrust level can be changed only by simultaneously changing the power and propellant supplied or by pulsing them. Pulsing implies accurate metering of propellant by valve opening and closing, which is difficult, and there are possible problems in starting the arc jet and ion rocket repetitively.

The pulsed plasma accelerator is by its very nature a pulsed device. Thrust level can be changed over a very wide range by merely changing the pulsing rate. The propellant is admitted in gaseous form by a trapped volume technique which insures accurate metering without concern for valve open time.

• **Early work**—Experiments were initiated at the Boeing Airplane Co.'s Advanced Propulsion Laboratory by the author early in 1960. The parallel rail configuration was chosen for simplicity. The experimental program was primarily an examination of possible accelerator efficiency, thrust level, and operating life time. Efficiency results later obtained with this unit indicated it might well be the optimum configuration.

TABLE I

Source of Torque	Approx. Torques on Typical Satellite Vehicle, Ft.-lbs.	Remarks
GRAVITATIONAL GRADIENT	10^{-3} — 10^{-6}	Maximum value for dumbbell configuration
EARTH'S MAGNETIC FIELD	10^{-5} — 10^{-7}	A function of internal currents, materials, and size.
SOLAR RADIATION PRESSURE	10^{-6} — 10^{-8}	Maximum value for 10-ft.-diam., half reflecting sphere.
INTERNAL TORQUES	7.4×10^{-6}	10 gm. mass at a radius of 1 cm. accelerated at a rate of 10 rad/sec^2.
AERODYNAMIC FORCES	3×10^{-6}	In 300-n.m. orbit, 10-sq.-ft. area with movement arm of 10 ft.

In the first experiment, the plasma was formed by exploding a fine copper wire which had been placed between the two parallel electrodes. In later experiments the plasma was formed by injecting a gas in between the electrodes. All the experiments were carried out in the vacuum of 10^{-4} mm Hg or less.

Three interesting conclusions were derived from these efficiency results. The first result shows it is possible to obtain reasonable efficiency from a confined parallel-rail-configuration pulsed plasma accelerator. The 50% to 60% efficiency at 5000 to 10,000 sec. I_{sp} was achieved with an accelerator and circuit which were not optimized, and it is anticipated that the efficiency can be further increased to the desired level of 70%-80%.

Secondly, the results tend to follow a theoretical efficiency curve. The only exception is the last or highest specific impulse point on the gas-derived plasma operation curve. This point fell well below the theoretical curve because not all of the available energy was converted into directed kinetic energy of the exhaust—the accelerator was too short and the plasma left the electrodes prematurely.

Finally, the gas-derived operation is better than wire-derived operation. This is somewhat heartening: the gas-derived operation is thought to be more practical because of certain mechanical problems in feeding a wire plasma source between the electrodes rapidly and reliably.

The higher efficiency of the gas-derived operation might possibly be attributed to the fact that with a wire-derived plasma accelerator, an outside circuit switch is necessary to prevent the capacitor from discharging until the wire is in place. This unit is an element of relatively high resistance in comparison to the rest of the circuit. In the gas-derived operation the admission of gas between the electrodes acts as a circuit switch, making it possible to do away with the outside circuit switch.

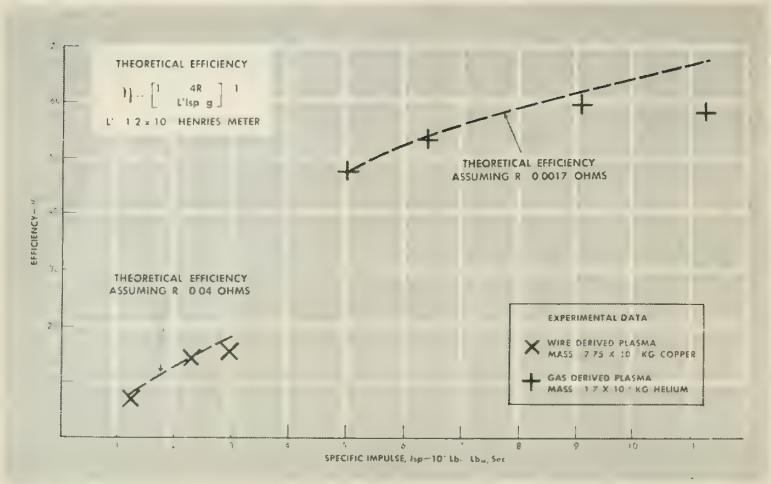
The efficiency results were considerably higher than those obtained in most previous experimental investigation of various pulsed plasma accelerator configurations. It is felt that there are three principal reasons for this improvement:

—In previous experiments the efficiency was calculated from a momentum measured by the impact between a plasma blob after it had left the accelerator, and a ballistic pendulum. That an error arose due to part of the plasma missing the pendulum is indicated by the reported critical positioning of the pendulum. The 50%-60% efficiency achieved was obtained by measuring the momentum on a spring-mounted accelerator where the impulse actually occurs. Furthermore, this data was independently checked within 5% with momentum calculated from a measured instantaneous current.

—The gas-derived plasma accelera-

TABLE II

Mission	Trajectory	Vehicle Wt., lbs.	Moment Arm, Ft.	Max. Req'd Thrust, lbs.
1 OBSERVE FIXED POINT ON EARTH'S SURFACE.	100-n.m. circular orbit.	5000	10	0.08
2 MAINTAIN SATELLITE AXIS POINTED TOWARD CENTER OF EARTH FROM ECCENTRIC ORBIT.	300-n.m. perigee eccentricity = 0.2	1000	5	5×10^{-6}
3 REMOVE ECCENTRICITY OF ORBIT.	300-n.m. orbit, initial eccentricity = 0.2	500	.....	50


THEORETICAL EFFICIENCY
L' 1.2 x 10 HENRIES METER
THEORETICAL EFFICIENCY ASSUMING R 0.0017 OHMS
THEORETICAL EFFICIENCY ASSUMING R 0.04 OHMS
EXPERIMENTAL DATA
WIRE DERIVED PLASMA MASS 7.75 X 10 KG COPPER
GAS DERIVED PLASMA MASS 1.7 X 10 KG HELIUM
EFFICIENCY
SPECIFIC IMPULSE, Isp—10 Lb. Lbm. Sec

EXPERIMENTAL RESULTS compare the performance of the gas and wire-derived plasma masses and performance of the parallel-rail accelerator.

tor which obtained 50%-60% efficiency used no outside arc switch to initiate firing, whereas previous experimental work involved such a unit.

—The confined parallel rail configuration itself is a contributing factor. It was found very early in this study that efficient operation meant constructing the accelerator with glass plates above and below the parallel electrodes. The resulting small confined volume between the electrodes prevented loss of the admitted propellant and escape of plasma during acceleration. The prevention of mass loss is very important since the reduced accelerated mass yields a reduced momentum which results in a reduced efficiency when related to the admitted propellant mass. Confining the mass between the electrodes is believed to be the major factor in the success of this configuration.

Furthermore, the small cross-sectional area has advantages over other configurations with larger cross-sectional areas between the electrodes. Brief experiments with large-area configurations have shown that the current between the electrodes tends to bunch up into one or two concentrated areas, rather than remaining diffuse and filling the entire space; as a result, part of the admitted mass is not accelerated. But the concentrated arc that occurs in the confined parallel rail accelerator can easily fill the small area between the electrodes, permitting better mass acceleration and higher efficiency.

• **Trouble spots**—Because the electrical propulsion system is a low-thrust system device, it must operate continuously for very long periods of time. These operating times are generally of the order of a year or more; any practical system must be capable of continuous operation without a single breakdown or decrease in performance.

In the pulsed plasma accelerator two possible sources of trouble are the accelerator electrodes and the energy storage capacitor. At present, the commercially available energy storage capacitors used in RF and radar pulse-forming networks are rated at pulsing rates of 1000 to 2000 pulses/sec. for 10,000 hours or more. Obviously, the energy storage capacitor will not be of major concern.

The electrode life problem was experimentally evaluated. The initial attack on the problem was made with an accelerator utilizing a 0.1 microfarad capacitor of the ordinary industrial type (since the special rapid-pulsing capacitors were not readily available). Two tungsten electrodes were attached directly to the terminal posts of this capacitor and covered with a lava insulator block. The capacitor was then charged continuously by a rectified half-wave, high-voltage power supply. The natural pulsing frequency was 500 pulses/sec. and the accelerator was operated for 10 minutes in this manner.

After the test an examination of the electrodes and the insulation material showed no apparent erosion.

The entire experimental program led to these conclusions.

—It is possible to attain efficiencies of at least 50% to 60% with a confined parallel-rail accelerator which uses a gas as the plasma source and the circuit switch.

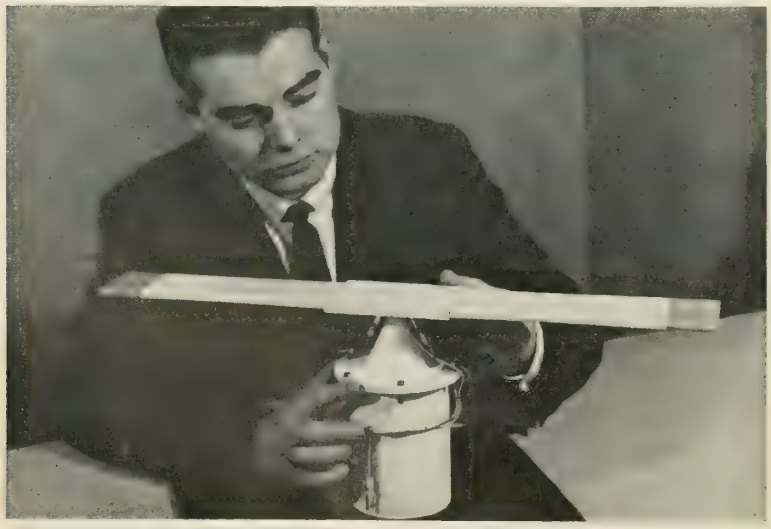
—A confined parallel-rail pulsed-plasma accelerator can be pulsed as rapidly as 1000 times per second by charging the capacitor and admitting gaseous propellant.

—Electrode life is not a major problem, since the accelerator electrodes show no erosion even at pulsing rates of 500 pulses per second.

—The excellent results achieved with the confined parallel-rail acceleration indicate it can be developed into a practical propulsion system.

Further experimentation is required in the areas of optimization of the confined parallel rail configuration, component development, and—finally—integration of the accelerator and the components into a working package. The acceleration experimental work will consist of examining initial capacitor voltages and the electrode length, size and spacing.

The critical components to be developed include propellant admission valves, materials, rapid pulsing capacitors and capacitor chargers. ⌘



MOCK-UP OF Rocket Research's proposed satellite attitude-control engine. The parallel-rail unit will develop a thrust of about 10^{-4} lbs.

Technical Countdown

ELECTRONICS

Super-Powered Laser Developed

Army scientists at Fort Monmouth report development of a 3-megawatt peak-output-power laser. This, they say, is 300 times more powerful than any other laboratory laser now in existence. Instead of employing the more conventional Fabry-Perot interferometer for optical pumping, the Signal Laboratory uses a reflecting prism and a laminated rotating mirror. The mirror limits pulse peak power to less than one nanosecond.

Better IR Horizon Scanners Sought

A new conception of an infrared horizon scanner for orienting space vehicles has been proven feasible, at least on paper, by scientists at NASA's Langley Research Center. The approach has been investigated in an attempt to find a system offering as many attributes as possible for size, weight, accuracy, etc. The result is a 1.8-lb. 3-watt sensor accurate to 0.25° (earth scan). The rotating, 4-germanium-lens system is expected to operate at all altitudes, indicate vehicle attitude, operate continuously for long periods of time, and reject false signals from the sun. First prototypes are now under construction at the Center.

Tube Sales Trail Industry Growth

The electron tube market will hit the $850-million mark this year, predicts D. Y. Smith, head of RCA's Electron Tube Division. This all-time high will result, he believes, because of the great expansion of the U.S. satellite and missile programs on top of the steadily rising electronics industry. Tube sales for 1961 totaled $823 million for an increase of 6% over 1960. (It should be noted, however, that the predicted 1962 increase only amounts to 3¼%, while the electronics industry as a whole is expected to increase sales by nearly 6½%.)

New Space-track Contractor Selected

Motorola's Western Military Electronics Division has been selected to perform the R&D for NASA's Goddard Range and Range Rate Tracking System. Conceived to assist the space agency's expanding satellite-tracking requirements, the initial program is estimated to cost over $3 million. The concept involves measurements of carrier and side-tone modulation to determine range and range rate up to cislunar distances. Spacecraft position in near-space will be measured to within a few feet, velocity within 1 ft./sec. Trailers will be air-transportable so that global stations can be moved readily to accommodate various satellite orbits.

Army Adding Zeus Discrimination Radar

A discrimination radar for the *Nike-Zeus* antimissile missile is being installed at White Sands Missile Range, Army officials have announced. The system—designed by Sperry Rand Corp.—will undergo extensive development testing to determine its capabilities to pin-point a ballistic missile warhead from a myriad of decoy devices. The system incorporates information on discrimination techniques from studies being conducted by Cornell Aeronatuical Labs. The Army says it is well along with a project to install a second discrimination radar at the Kwajalein Island Test site.

Oxygen Sensor Developed for Space Vehicles

Using the principles of the hydrogen-oxygen fuel cell, General Electric engineers have experimentally tested a sensor to detect dangerously high or low levels of oxygen in a space capsule, the Company announced recently. The sensor—operating essentially as an ion-exchange membrane fuel cell—indicates the amount of oxygen present in a space capsule in terms of an electric current which can then be read by a milliammeter. Advantages of the system, according to GE, are its simplicity, small size, and self-powering features, and the high-level output signal.

PROPULSION

Titan II Restart Capability Tested

Aerojet is understood to have conducted several restart tests on the second stage engine of *Titan II*. Runups of more than 20 seconds were made 22 times on one engine in a 5-hour period—followed later by eight firings in 1 hour.

SUPPORT EQUIPMENT

Arnold Tunnel Gets High-Energy Power

A high-energy power supply producing direct current pulses of over 100 million joules has been installed at the Air Force's Arnold Engineering Development Center. Designed to power the Center's new hypersonic wind tunnel (when completed, it will be the largest in the country and the only one capable of testing full-scale nose cones), the d-c supply is built up from ordinary power levels in an inductive two-stage energy storage system and then released in 0.01 sec. To insure maximum safety, the entire system—designed and installed by General Electric Co.—will be remotely controlled through a closed-circuit television system.

Army Saves Money With Towbee System

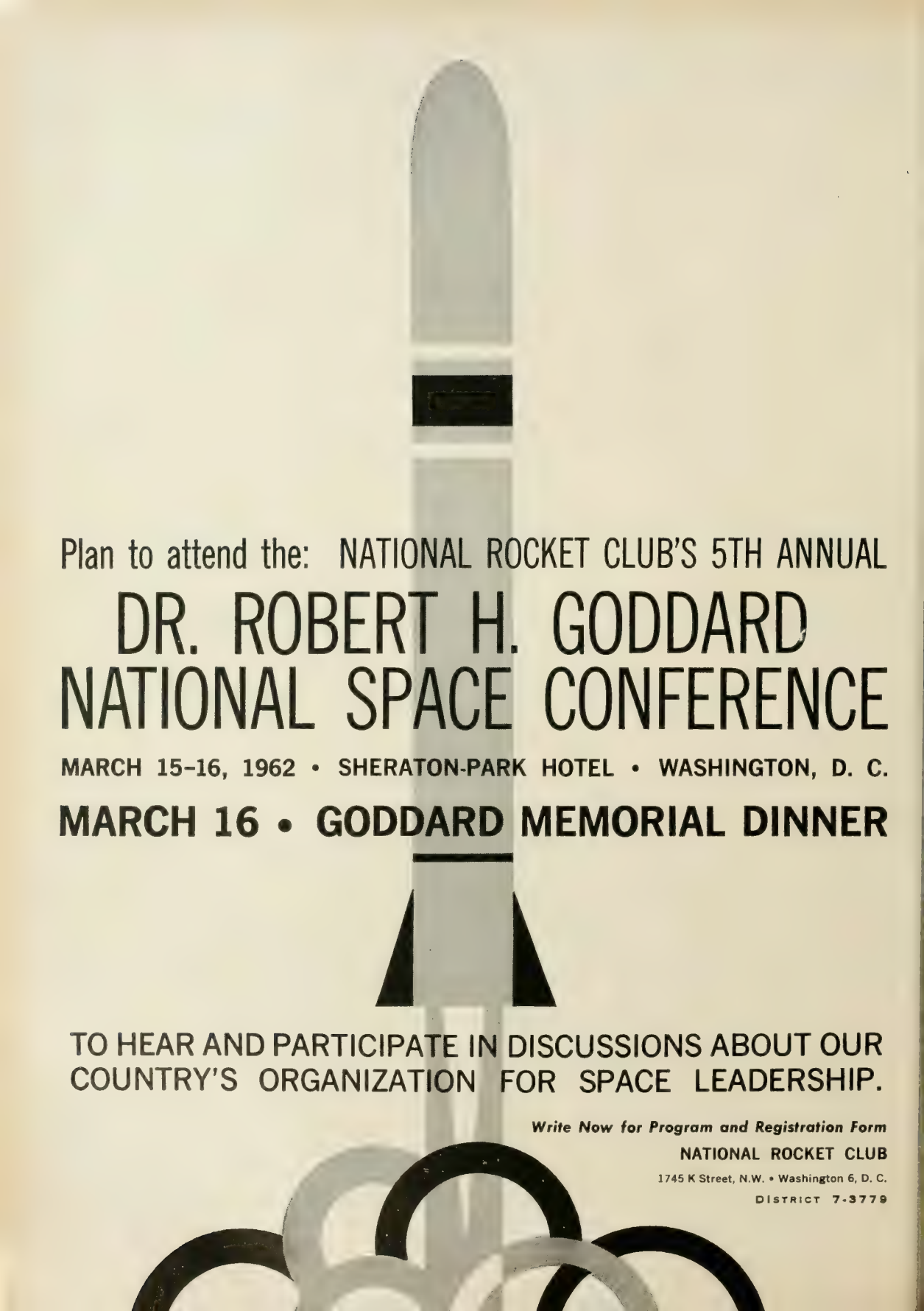
A Ryan *Firebee* target drone is being used by the Army to tow a less expensive target during firing tests at White Sands Missile Range. The "Towbee" system, Ryan Aeronautical Co. says, will permit considerable cost savings to the Army by allowing it to re-use the powered drone numerous times after its parachute recovery.

Target Missile Tests Successful

Demonstration firings of the Navy's *Targeteer* missile have been successfully completed, reports the system developer, Aeronca Manufacturing Corp. Designed to demonstrate the system's capabilities for shipboard firings, the tests were conducted at the Navy's White Sands Missile Test Facility. *Targeteer* will be used for evaluation and testing of the Navy's tactical missiles at altitudes up to 60,000 ft.

Collapsible Container Built for Nose Cones

An all-purpose, collapsible container for shipping and handling satellite nose cones has been developed by an engineer at Lockheed Missiles & Space Co. The main advantages of the container, according to developer Al Welch, are that it can be re-used, easily assembled, molded to various cone shapes, and will cut the time required to manufacture shipping containers. Lockheed estimates that the device will reduce handling costs by approximately $30,000 a year.



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New Bio-Med Pack Adaptable to Apollo

Garrett system designed primarily for astronaut safety features 'doctor's office' displays on ground

by Arthur H. Collins

LESS-THAN-6-LB. pack in advanced version of new system includes arm band and temperature transducers. Standard EKG display unit at left is for ground stations.

A LIGHTWEIGHT bio-medical instrumentation system with simplified readout is being developed by The Garrett Corp.'s AiResearch Mfg. Co. of Los Angeles.

The bio-med pack, designed for extended manned orbital flight applications, complements the company's recently-awarded responsibility for the *Apollo* life support system. The bio-med system in its present form has no direct *Apollo* application, but with minor modifications could be adapted to a space-vehicle environment.

Weighing less than six lbs., the transistorized package will provide all of the necessary basic life-support data outputs — electrocardiograph (EKG), blood pressure, pulse rate, respiration rate and body temperature.

An outstanding feature is the system's ability to provide straightforward, unsophisticated signals through the telemetry system to ground receiving and readout stations. This provides ground stations with direct readout capability in normal clinical terms. In essence, a ground-based medical officer can deal directly with values with which he is completely familiar and experienced.

In the new unit, for example, a standard "doctor's office" EKG display can be incorporated. Temperature and pressure readings are displayed either by direct-reading meters or strip recorders.

Earlier methods of medical data readout often left a small area of possible error or misinterpretation, and sometimes a time lag while a computer tabulated the incoming data. The AiResearch approach enables medical specialists to work with established medical standards and immediately evaluate all data received for necessary action.

"Our primary concern is the safety of the man in space—all else is secondary," said Dr. James N. Waggoner, Garrett's director of aerospace medicine. "The new bio-med unit has been designed with this in mind."

The bio-med pack is basically an expansion of the AiResearch EKG read-out system that was built for Lt. Col. John Glenn's *Mercury* capsule flight. In the *Mercury* system, Glenn inflates an arm cuff for blood-pressure checks by squeezing a pressure bulb four or five times prior to each check. Three blood-pressure checks are made each time the capsule passes over a ground station. There are six station check points, each positioned approximately one-sixth of the way around the earth.

In the new bio-med unit, blood-pressure checks will be automatic. The cuff will be inflated from a compressed-air bottle initiated by the timing system and requiring no effort or concentration by the astronaut. The compressed-air bottle contains a sufficient volume and requiring no effort or concentration by the astronaut. The compressed-air bottle contains a sufficient volume of air, at approximately 1100 psi, to inflate the arm cuff over 300 times—far exceeding mission requirements.

The system is programed to operate automatically during the initial six minutes after launch, starting at count-down-zero. It will then switch on and off at predetermined intervals, to provide data to the six ground stations monitoring the astronaut as he orbits the earth. To cover the re-entry period, the unit is again switched on for continuous operation during the last six minutes of flight. At any time during the flight the astronaut could initiate operation of any check if he feels the need to do so. By simply pushing a button on his control panel, he could immediately transmit to the nearest ground station all current bio-med information.

Functions

• **Electrocardiograph** — The EKG section consists of an inflatable arm band with two built-in sensors and associated electronics. Each sensor includes a small ultrasensitive microphone and a pressure transducer. The microphone, like all of the other sensors, has been specially designed by AiResearch for this particular application. Through an analysis of heart sounds, an optimum frequency in the low audio range has been selected—to provide the most accurate reproduction of the systolic (the pumping action of the heart) and diastolic (the rest phase) heart actions. The miniature microphone is sharply tuned to this frequency.

• **Blood pressure** — Blood-pressure data are obtained from the small pressure transducer in the arm band. The term "blood pressure" usually refers to the systolic pressure in the brachial artery, due to the heart contraction, while diastolic pressure is the pressure of the blood in the brachial artery when the contraction force exerted has reached the lowest point. The difference between systolic and diastolic pressures is known as the pulse pressure and represents the volume output of the left ventricle. Normal blood pressure of an adult male is 120 systolic—80 diastolic.

Deviations in the blood-pressure reading as received on the ground have a definite bearing on the astronaut's safety and may be interpreted as danger symptoms. An increase in the systolic blood pressure occurs as a result of exercise, application of cold to the skin, or emotional excitement. A rapid decline of blood pressure is a sign of shock or internal hemorrhage.

• **Pulse rate**—The EKG section is also used to obtain pulse rate information. By counting heart beats over a set time interval depending on recorder speed, pulse rate is obtained. Normally, pulse rate differs in individuals; the average male adult rate, however, is 70 beats per minute. Pulse rate may change when there is severe pain in any part of the body.

A marked increase in cabin temperature caused by re-entry will show up as an increased pulse rate, usually increasing about 10 beats per minute for one degree of elevation of temperature. The temperature and heart rate rise and fall together.

• **Respiration rate**—This measurement is obtained from a small thermister placed in the space helmet close to the nasal or mouth passages. As the astronaut exhales, the difference between body temperature and ambient internal capsule temperature is recorded as a resistance difference. The respiration rate thermister is the cylindrical sensor shown in the hand in Fig. 1.

Average respiration rate for a healthy adult is from 14 to 18 per minute, with a fairly uniform relationship between the frequency of the pulse and the respirations in the proportions of one respiration to four or five pulse beats.

An increase in cabin temperature will also increase respiration rate. The effects of a faulty air-conditioning unit in the space capsule could be shown on on the ground as increase in the astronaut's respiration rate, since carbonic acid directly stimulates the respiratory center. Certain changes in atmospheric pressure also increase respiration rate—possibly indicating damage to the spacecraft caused by a meteoroid strike.

• **Body temperature** — Measurement of body temperature is obtained from small thermisters taped to the surface of the skin of the astronaut. The placement of the thermisters varies with each astronaut's specific desires of comfort. A deep probe, specifically a rectal thermometer, has been used in past *Mercury* shots and gives by far the most accurate results. The use of rectal thermometers, however, is for obvious reasons limited to short time periods and not appropriate for long-term orbiting. Hence, the use of skin surfaces is proposed.

Because exposure to cold stimulates the body to produce more heat for protection from losses by radiation and conduction, a loss in cabin heat will show up in this read-out area. A very high external temperature upsets the balance of heat regulation by direct action on the heat-regulating center in the brain, and may produce an increase in body temperature.

Other noticeable changes that can be seen on the ground readout as increases in body temperature are; nervous impressions, hysteria, and prolonged or extreme pain.

• **Electronics**—The bio-med pack's associated electronics circuits have been designed with the utmost simplicity in mind, to enhance reliability and consequently the safety of the astronaut.

The photo on p. 39 shows an advanced version of the new system, including arm band and temperature transducers. The unit on the left is a standard EKG display unit and would normally be found at the ground stations.

Although shown in a portable chassis, the bio-med unit can be stored in any available capsule space, with electronic connections made through cables to the umbilical cord on the astronaut's space suit.

The pack uses 24 volts DC directly from the power supply of the capsule. Power consumption is approximately 25 watts, 23 of which is used by the motors, timers and relays of the automatic program sequencer. The motors are used primarily to turn valves on and off to control the inflation sequence of the arm cuff for EKG and blood-pressure readouts.

Replaceable circuit cards minimize problems of maintenance and repair, and conventional transistor circuits are used throughout. The temperature and pressure transducers are designed around Wheatstone bridge principles, enabling the use of simple output circuit amplifiers. All circuits are designed to keep outputs within a 1½ volt DC limit, so that any standard telemetry system can be used and yet retain the necessary accuracy.

Future advancements of the systems may come in the form of a small refined FM transmitter taped to the arm of the astronaut—eliminating cables and wires and permitting the astronaut complete mobility within the shirt-sleeve environment of his capsule. The FM receiver could be conveniently located in available space in the capsule, and data then telemetered to earth. ⌗

Aluminized Mylar Tops as Insulator

NRC reports 'crinkling' gives material best known efficiency for cryogenics

by James Trainor

A NEW superinsulating material—reportedly seven times as efficient as the next-best material—has been developed literally by adding a new twist to an old idea.

Aluminized Mylar, although rejected by many companies due to its poor performance, has the highest insulation efficiency of any known cyrogenic insulation material, according to its developers, National Research Corp. The secret of the NRC insulator, they say, is the technique of "crinkling" the material as well as controlling the number of layers per inch and controlling the thickness of the coatings.

• **Effective radiation barrier**—Designated NRC-2, the material insulates by using multiple radiation barriers of aluminized Mylar to act as separate heat shields, Consisting of a sheet of Mylar about .00025 in. thick and of an aluminum coating approximately .000001 in. thick, the insulator is applied in layers, thus providing separate individual heat barriers.

Crinkling or crumbling the material reduces the area of contact between sheets. This decreases the amount of heat conduction from one sheet of Mylar to another—increasing the efficiency of the individual layers of material.

This hundred-fold reduction in lateral heat conductivity is what makes possible the high efficiency of the aluminized Mylar, effectively eliminating the problem of interlayer contacts.

The lower lateral heat conductivity of NRC-2 also minimizes the problem of heat leaking into the insulation from the edges of the material. In addition, heat intake through conduction by gas molecules between layers is prevented by keeping the material under high vacuum.

LEFT: *Superinsulating material is shown being subjected to laboratory test to determine its exact efficiency. Aluminized Mylar is wrapped around a test sample of liquid nitrogen and inserted into a cryogenic calorimeter in which the amount of vaporization is measured to determine material's efficiency.*

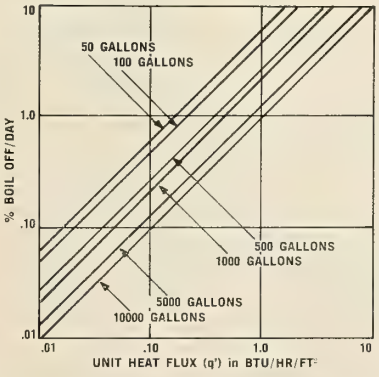


CHART illustrates the rate of boil-off of liquid hydrogen due exclusively to loss through the Mylar insulation. Calculations do not take into account conductive losses.

Unlike aluminum foil insulation materials, the aluminized Mylar need not be separated from an adjacent layer by heavy asbestos or fiberglass—thus a significant weight-saving can be realized.

Again, since the Mylar insulator is not subject to thermal shorts, there is not the danger of a short occurring when the aluminum foil is holed or allowed to come in contact with another insulating foil. This further reduces the difficulty and expense of designing and installing cyrogenic insulators.

• **Other advantages**—In addition to the weight savings obtainable, the aluminized Mylar has several other significant advantages: extreme pliability, strength and resiliency. These features allow the material to cover unusual shapes such as spheres, pipes and valves without tearing, and to return to its regular configuration after the high g loads of, for example, a missile launch.

Presently in use as an insulator for cryogenic liquid fuel storage tanks, NRC-2 has proved it can significantly reduce the boil-off rate of these extremely volatile liquids.

It is also likely to be used as an insulator for accelerometers, floating gyroscopes and other devices which require a relatively constant temperature.

Patented by its developer, Dr. Milo R. Hnilicka of NRC's Research Division, the material is being used by the Standard Steel Corp. and Hoffman Laboratories under license for all sizes of cryogenic ground storage and transport vessels. Several other companies have been nonexclusively licensed to use the material in missile and space applications.

However, the company plans to sell and license the material to other firms. ⌘

Douglas Warns Bigness May Be Needed

THE PRESIDENT of Douglas Aircraft Co. suggested last week the government should look more favorably on prospective mergers. He also called for "fresh thinking" on the government's contract negotiation policies.

Speaking before the Associated Business Publications Forum in New York Donald Douglas Jr. said: ". . . there may well be cases when merger will contribute to a strengthening of our industrial base."

In foreign commerce, he said, the only way we may be able to meet increasing competition of the Common Market is through "creation of new, larger enterprises capable of achieving lower costs."

"Our public statements, our legislation, and the conduct of our business should be grounded on the understanding that what is big is not necessarily bad, that bigness doesn't always stifle competition, and that in some areas we may actually need more bigness."

"It may not be possible, or desirable," Douglas said, "to have a set national policy on mergers. But it should be possible to develop answers to a specific situation on a more coordinated and streamlined basis."

On renegotiation, he said:

"There can be little argument with the concept of renegotiation as applied during a wartime situation. But there is a very real question whether its continuance is justified, and whether it has not in recent years become, in fact, a supplemental tax levied against managerial efficiency. That certainly wasn't its purpose in the first place."

(Meanwhile, the Justice Department told Ling-Temco-Vought, Inc. that the Government will not appeal a judge's decision to reject the Government's antitrust suit against the company.)

(A Nov. 24 ruling in U.S. District Court said that the merger of Ling-Temco and Chance Vought did not "in any way lessen competition in the aerospace industry," as the government contended in antitrust action.)

SYLVANIA ELECTRIC PRODUCTS INC. will build a 77,000-sq.-ft. addition to its Reconnaissance Systems Lab in Mountain View, Calif. The addition, part of Sylvania's Electronics Systems, will house primarily lab areas and offices for staff and engineering work.

Sylvania said there will be no major increases in personnel during the expansion program.

DYNAMICS CORP. OF AMERICA has formed a third British subsidiary, Digital Measurements, Ltd., to design and produce factory automation and data-processing equipment and systems for industrial plants in Britain and Western Europe.

DM will concentrate initially on R&D of equipment and systems, with production scheduled to begin by May.

DATEX CORP., a subsidiary of Giannini Controls Corp. is building the first unit of a 48,000-sq.-ft. plant in Monrovia, Calif. The building will include a "white room" for manufacture of high-precision shaft position encoders.

GUIDANCE CONTROLS CORP. has been acquired by Warner Electric Brake & Clutch Co., Beloit, Wis., in a cash transaction. GC, makers of precision devices including potentiometers and encoders for missile guidance systems and other military uses, will operate as an independent subsidiary under its present name.

LEAR, INC'S Instrument Div., Grand Rapids, Mich., has moved into a 50,000-sq.-ft. manufacturing facility addition, primarily devoted to design and manufacture of ground support equipment.

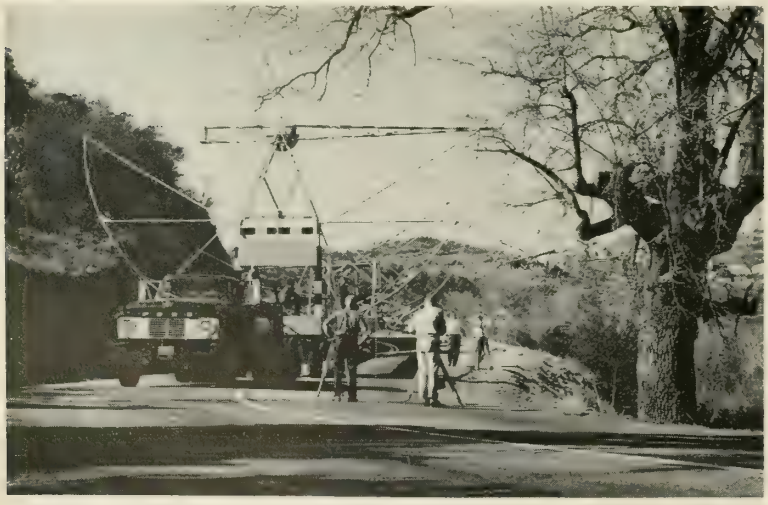
The facility includes 9000 sq. ft. of clean rooms for assembly and servicing of high-precision instruments.

RAYTHEON CO. merged its Aero Weapons and Missile & Space divisions to combine research, development, design, test, production and field service of military equipment programs from concept through operational use. The combined units will be called the Missile and Space Division.

BERNARD ELECTRONICS CO. was formed in Washington, D.C. to design and engineer components in such fields as radar, beacons and IFF systems, voice communications, data transmission, special-purpose computers and special-purpose receivers.

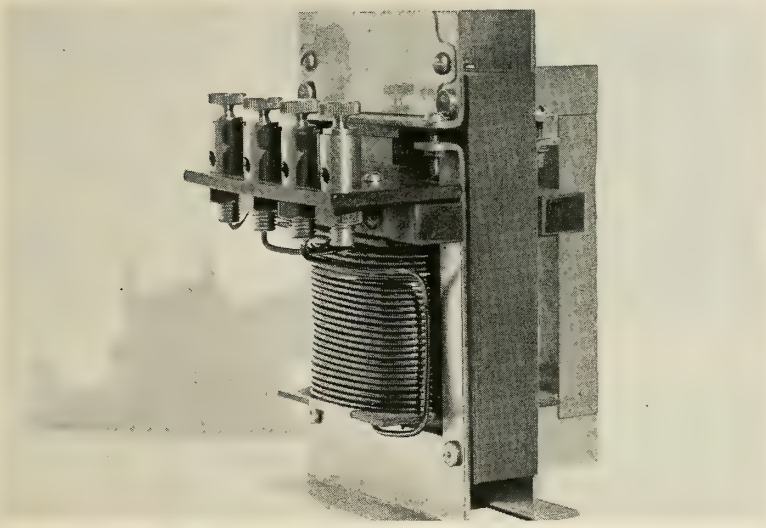
ROCKETDYNE division of North American Aviation, Inc., established a Process Equipment operation and consolidated Central Marketing and Contracts and Proposals.

The Process Equipment operation will incorporate technical activities of the former Process and Special Equipment Engineering functions. It will be responsible for analysis, engineering and design of processes and related equipment for application in the chemical and defense industries.



Advance Men for Saturn S-II

CREW FROM North American Aviation's Space and Information Systems Div. uses 35-ft.-wide road gauge, believed to be largest in the U.S., in recent survey of roads between Port Hueneme, Calif., and company's Santa Susana testing facilities. Saturn S-II booster second stage will eventually be trucked overland for testing.



New Product of the Week:
Battelle Voltage Regulator

THE MAGNETORESISTANCE voltage regulator developed by Battelle Memorial Institute and designed specifically as a supply source for a tunnel diode, is one of the first practical devices to use the phenomenon of magnetoresistance. Output voltage is kept constant by an indium-antimonide semiconductor, measuring ¾ by ¼ by 0.004 in., whose resistance varies in proportion to the strength of an applied magnetic field.

The regulator can maintain a 0.15-volt output within ±5% at 0.1 amp.—even when load resistance changes 50% with a simultaneous 10% change in input voltage, which is normally 1.5 volts.

Circle No. 225 on Subscriber Service Card

Sapphire-To-Metal Seals

Advanced Vacuum Products, Inc., is marketing a line of sapphire-to-metal seals, ideal for windows subject to vacuum and/or extreme temperatures.

The seals, tested for a maximum permissible leak rate of $1x10^{-9}$ cc of helium per sec., remain hermetic even after repeated bake-outs at temperatures as high as 800°C.

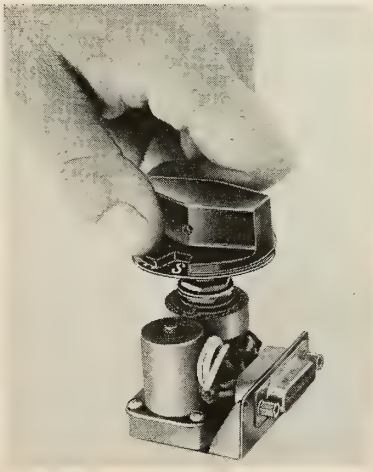
The sapphire discs generally used are 2 in. in diameter and from 0.100 to 0.125 in. thick, although these dimensions may be varied to suit specific needs. After the discs are metallized with a special moly-manganese solution, they are furnace-brazed to the metal component, usually grade A nickel, Kovar, or nickel iron.

Circle No. 226 on Subscriber Service Card

Arm-Safe Switch

An arm-safe switch is available from the Janco Corp. It is especially designed to perform the arm-safe switching function in the nose cone of an air-to-surface missile. An interlock prevents rotation of the switch to the "arm" position without first receiving an appropriate electrical impulse. Designated the Series 2018 switch, it is an adaptation of Janco's Series 1900 miniature switch.

Circle No. 227 on Subscriber Service Card



Smallest Potentiometer

The smallest, lightest, potentiometric accelerometer for aerospace programs is available from Beech Aircraft Corp.

The single-axis accelerometer, a two-axis inductive pick-off type and an adaptive force vector resolver will be marketed simultaneously by the company's aerospace division.

The potentiometric accelerometer—1.33 oz. and .6 cu. in.— is said to be more accurate than existing types and boasts a variety of full-scale ranges from ±3 to ±100 g.

Circle No. 228 on Subscriber Service Card

I-F Circuit Reflectometer

A reflectometer which can be employed in i-f circuits is available from Merrimac Research and Development, Inc.

Two models of the i-f reflectometer were disclosed. One, designated IR-1, possesses coupling characteristics which are flat across the frequency band from 100 Kc to 25 Mc; the other, designated UR-1, is flat across the band from Mc to 200 Mc.

Connected back to back, Merrimac reflectometers can be used as the heart of an impedance-matching circuit to couple a signal source to i-f strips, i-f detectors, mixers, or antennas. Single reflectometer units can be conveniently employed to measure voltage standing-wave ratios; a continuous VSWR sampling circuit for insertion into a line can be made up of two units back to back. The directivity of the i-f reflectometer is nominally 25 db, resulting in a measurement accuracy of 10%.

Circle No. 229 on Subscriber Service Card

Metalized Ceramic Tubes

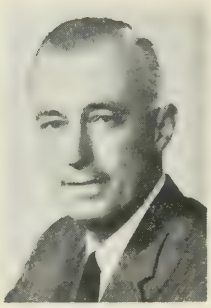
Ceramics International Corp. is marketing high-temperature metalized tubes for precision electronic applications.

Special CI-engineered equipment and metalizing techniques metalize the inside of ceramic tubes in sizes varying down to 0.080-in.-ID. Ends of the tubes can also be metalized where required. Maximum tube length is approximately 8 in.

The ceramic utilized is 90-97% pure alumina. CI's high-temperature moly-manganese metalizing techniques produce a bonding strength of 15/20,000 psi. The metalized surface is stress-free nickel-plated and then coated with tin, lead tin, tin silver, or whatever coating the customer requires.

Circle No. 230 on Subscriber Service Card

SLIEPCEVICH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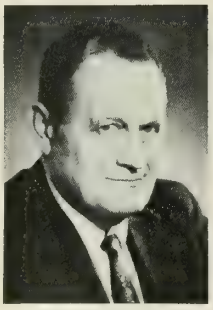
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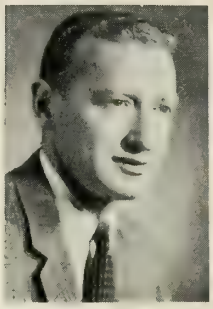
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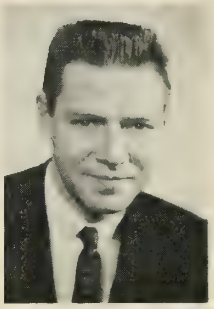
MYERS

Dr. Ludwig Roth, Dr. V. W. Howard, Alan Morgan and **George Mangurian:** Given key management positions in the newly established Northrop Space Laboratories. **Roth** is vice president and manager, Systems Engineering Department; **Howard** was made vice president and manager, Research Department; **Morgan,** vice president and manager, Business Administration Department; and **Mangurian** is in charge of management of the Applications Engineering and Planning Department.

W. J. Cecka, Jr.: Will be manager of a sixth product operation, Process Equipment, Rocketdyne Division, North American Aviation, Inc. Also, due to consolidation of Central Marketing and Contracts and Proposals divisions, the following major management appointments were made: **E. J. Brown,** vice president, contracts and proposals; **E. B. Gallant,** director, administration and engineering operations; **W. D. Crossland,** engineering manager, process equipment; and **L. E. Steward,** assistant director, contracts and proposals.

Frank Coughlin, Jr.: Appointed vice president and a director of Burr Electronics, Inc., Cos Cob, Conn.

L. M. K. Boelter: Dean of the College of Engineering at the University of California since 1944, has been elected to the board of directors of Servonic Instruments, Inc., Costa Mesa, Calif.

Dr. C. M. Sliepcevich: Named to the Board of Directors, Autoclave Engineers, Inc., Erie, Pa.

Ryndal L. Wetherington: Selected by board of directors of Research Management Corp., Washington, D. C. as vice president.

Emanuel Weintraub: Executive vice president and general manager of the John E. Fast & Co., Chicago, elected a vice president of The Victoreen Instrument Co.

Chester Bland: The president of Bland Burner Co., H. P. Townsend Manufacturing Co. and Cleveland Tapping Machine Co., has been made a director of Tubotron, Inc., Newark, N. J.

David S. McNally: Will serve as vice president of the Amphenol Connector Division, Amphenol-Borg Electronics Corp. and as general manager of the Amphenol-Western Division, Chatsworth, Calif.

Dr. Harvard L. Hull: President of Hull Associates, Chicago, selected to serve as a member of the board of directors of Frederick Research Corp., Wheaton, Md.

Frank B. Carder, Russel J. Keller, and **Neal H. Hundt:** Will fill three new divisional vice presidencies in American Machine & Foundry Company's Government Products Group. Carder will direct the Engineering Unit, Keller the Manufacturing unit, and Hundt will be legal counsel and contracts administrator. Also, **Jerome P. Mullin** has been made product line manager for space-simulation devices for ACF Electronics division.

Arthur B. Marsh: Named chairman of the board of directors of Aerospace Nylok Corp., Hawthorne, N. J.

Lawrence Mendelsohn: While retaining his seat as a member of the board of directors of Wells Industries Corp., will fill the position of vice president, Marketing, for Assembly Engineers, Inc., Los Angeles.

Roger D. Farnham: Appointed vice president and general manager of Coleman Electronics, Inc., wholly-owned subsidiary of Coleman Engineering Co., Inc., Los Angeles.

Malbon H. Jennings: Former director of Sperry central marketing organization, selected as vice president for marketing of Sperry Gyroscope Co., Great Neck, N. Y.

Dr. Peter B. Myers: Accepted the position of manager of a new Research and Advanced Technology department in the Aerospace Division, Martin Marietta Corp., Baltimore.

Edward T. Clare: Vice president-marketing of Cohu Electronics, Inc., Kin Tel Division, and **Ernest A. Massa,** vice president and general manager of the Massa Division, both elected vice presidents of the parent corporation.

John F. Christie, Jr.: Lockheed Missiles and Space Co., named president of the Aerospace Electrical Society for 1962; **Robert H. Jerome,** Missile and Space System Division, Douglas Aircraft Co., was made vice president; and **James E. Johns,** Lockheed Missiles and Space Co., treasurer and director of finance. **Leslie T. Isaacs,** Douglas Aircraft Co., is the new secretary and director of administration.

John J. Shea: Appointed director of research at Cosmic, Inc., Washington, D. C.

Dr. Samuel G. Lutz: Named chief scientist of Hughes Aircraft Company's research laboratories, where he will direct studies of satellite communications.

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contracts

AIR FORCE

$23,781,147—**Martin Marietta Corp.**, Baltimore, for research and development of *Titan II* missiles and for design and production of *Titan I* missiles.

$18,400,000—**Lockheed Aircraft Corp.**, Sunnyvale, Calif., for research and development on space satellite vehicles, for *Agena* space vehicles and for long-lead-time follow-on items for same (3 contracts).

$6,000,000—**Douglas Aircraft Inc.**, Santa Monica, Calif., for further research, development and testing of the *Skybolt* missile.

$5,744,483—**Philco Corp.**, Palo Alto, Calif., for production of satellite control and vehicle tracking systems.

$4,361,000—**General Motors Corp.**, Milwaukee, for production of guidance systems for *Titan* missiles.

$3,500,000—**General Electric Co.**, Syracuse, N. Y., for research and development of airborne guidance equipment in support of space programs.

$3,475,000—**Boeing Co.**, Seattle, for the *Minuteman* system engineering test program (supplemental contract).

$3,000,000—**Page Communications Engineering, Inc.**, Washington, D. C., for engineering, furnishing and installing of a tropospheric scatter communications system.

$2,294,700—**General Electric Co.**, Syracuse, N. Y., for providing materials and services for the air defense radar program.

$2,000,000—**Martin Marietta Corp.**, Baltimore, for research and development of a space program launch vehicle.

$1,800,000—**Rand Corp.**, Santa Monica, Calif., for research in the aerospace sciences.

$1,700,000—**General Dynamics**, San Diego, for providing aerospace ground equipment (supplemental contract).

$1,600,000—**Space Technology Laboratories, Inc.**, Los Angeles, for continued site activation and engineering for the *Titan, Atlas* and *Minuteman* ICBM's.

$1,120,000—**American Bosch Arma Corp.**, Garden City, L. I., N. Y., for development of the *Atlas* missile guidance system (supplemental contract).

$1,069,800—**Ramsdell Construction Co.**, Dallas, for construction of a missile assembly and maintenance support building, and technical supply facilities at Little Rock AFB, Ark.

$500,000—**Houston-Fearless Corp.**, Los Angeles, for development and fabrication of a controllable development processing machine and installation and engineering services.

$200,000—**United Testing Laboratories Division, United Electrodynamics, Inc.**, for reliability research and testing of electronic equipment.

$177,441—**Sperry Phoenix Co., division of Sperry Rand Corp.**, for magnetic azimuth detectors and spare parts for aerospace ground equipment and data.

$140,492—**Raytheon Co.**, Lexington, Mass., for spare and repair parts for *Hawk* missile system.

ARMY

$4,925,833—**Hercules Powder Co.**, Wilmington, Del., for rocket motors and gunpowder.

$3,800,000—**Autonetics, division of North American Aviation, Inc.**, for procurement of the portable ABLE gyrocompass.

$3,593,031—**Sperry Rand Corp., Sperry Utah Co.**, Salt Lake City, for engineering services on the *Sergeant* missile.

$1,525,761—**Western Electric Co.**, New York City, for *Nike-Hercules* technical manuals.

$1,257,772—**Thiokol Chemical Corp., Redstone Division**, Huntsville, Ala., for procurement of plastic nozzles for first- and second-stage rocket motors of the *Pershing* ballistic missile.

$1,199,000—**Bridgeport Brass Co.**, Riverside, Calif., for rocket motors and motor closures for the *M-72* light assault weapon.

$1,037,875—**FMC Corp.**, San Jose, Calif., for *Pershing* missile carriers.

$504,900—**Consteel-Ets-Hokin and Galvan**, Cocoa Beach, Fla., for construction of an extension to the umbilical tower for *Saturn* launch complex 34, Cape Canaveral.

$338,000—**Ryan Aeronautical Co.**, San Diego, for continued support for *Firebee* target drone operations at the White Sands Missile Range, N. M.

$185,640—**Davis Bros. Construction Co.**, Abilene, Tex., for rocket assembly building, additional multi-cubicle magazine, at Perrin AFB, Sherman, Tex.

INDUSTRY

$8,500,000 — **Westinghouse Electric Corp.**, Washington, D. C., from **Aerojet-General Corp.**, for continued design and development in connection with the *NERVA* rocket engine project.

$4,000,000—**Temco Electronics Division, Ling-Temco-Vought, Inc.**, from **Autonetics, a division of North American Aviation, Inc.**, for continued manufacture of actuators for the *Minuteman ICBM*.

$750,000—**Acoustica Associates, Inc.**, Los Angeles, from **General Dynamics/Astronautics**, for site activation work on the *Atlas F* program.

$750,000—**Hughes Aircraft Co.**, Culver City, Calif., from **Pomona division, General Dynamics Corp.**, for continued development of an advanced guidance unit for the *Mauler* tactical air defense system missile.

$124,000—**Space Technology Laboratories, Inc.**, Los Angeles, from **Hughes Aircraft Co.**, for a solar simulator for the Aerospace Group.

NASA

$3,000,000—**Motorola, Inc.**, Scottsdale, Ariz., for research and development of the Goddard Space Flight Center range and range tracking system.

$994,081—**International Business Machines**, Rockville, Md., for five guidance computers for the *Saturn* vehicle program.

$354,215—**Electro-Optical Systems, Inc.**, Pasadena, Calif., for additional research and development on electric propulsion engines.

$115,000—**Bechtel Corp.**, Vernon, Calif., for architectural-engineering design of construction of expansion of the Test Divisions blockhouse, two 28,000-gal. liquid oxygen storage tanks and partial construction of a liquid hydrogen test facility a Marshall Space Flight Center.

$94,855—**Engineering Maintenance Inc.**, San Jose, Calif., for modification of space flight simulation laboratory, Ames Research Center, Moffett Field, Calif.

NAVY

$15,000,000—**Sperry Gyroscope Co.**, Great Neck, L. I., N. Y., for design, production and installation of navigation equipment aboard 10 new *Polaris* submarines.

$9,773,037—**Radio Corp. of America**, Moorestown, N. J., for tracking radar systems for use in satellite and missile test programs at the Atlantic Missile Range and for dismantling and modification of a tracking radar at St. Nicholas Island and reinstallation at Point Pillar in the Pacific Missile Range complex (2 contracts).

$6,000,000—**Magnavox Co.**, Fort Wayne, Ind., for airborne radar systems and classified military items.

$2,569,170—**Northrop Corp., Radioplane division**, Van Nuys, Calif., for production of *KD2R-5* target drones.

$2,244,415—**General Dynamics Corp., Electric Boat Div.**, New London, Conn., for design studies and equipment for the planned Fleet Ballistic Missile Training Center at Charleston, S. C.

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A Plan for Engineers

"SCIENTISTS AND ENGINEERS are a scarce but vital national resource. . ."

That quote is from the recent report of the National Science Foundation which carries the title, "The Long-Range Demand for Scientific and Technical Personnel—A Methodological Study."

The study estimates that the demand for scientists and engineers may double by 1970. Yet both the absolute and relative number of college freshmen enrolling in engineering is decreasing for perhaps the fourth successive year.

President Kennedy has called the situation one of the most critical problems facing the nation. Last month, he ordered his scientific advisers to draw up a report on how the U. S. can cure the shortage in the fastest possible manner.

We think these advisers could, with benefit, spend some time studying the Letters column of this magazine.

In the Jan. 1 issue, we ran an article by Associate Editor Heather David on the increasing shortage of scientists and engineers as it affects the missile/space industry. Few articles have drawn such a heavy reader response. Several of the letters appear in this issue.

A significant unanimity of opinion runs through almost all of the letters: one of the quickest solutions toward curing the shortage of engineers lies in making better use of the engineering talent already available.

". . . many so-called 'old' engineers (45 to 65 years of age) have been cast out. These 'old' engineers can save millions of dollars, in time wasted by young engineers, due to their past experience in design. . ." writes an Alabama engineer.

"My contention is that the non-graduate 'semi-professional' can and will be the answer to the problem," writes a Colorado engineer.

"The problem of the old engineer is very true . . . the situation is even worse than . . . pictured," writes the wife of a California enginer.

"There very definitely is poor utilization of existing scientific and engineering personnel," writes a Pennsylvania engineer.

"I feel that on-the-job training can be just as important as school. Why must we undergraduate students waste our (summer) time on pick and shovel jobs?" asks a Washington engineering student.

Here are some areas which definitely need investigating. Are we wasting the talents of qualified graduate engineers on unnecessary tasks? Are we overlooking the vast talent pool available among older engineers? How can we best employ the experienced professionals who have no formal degree? Are we failing to keep our engineering students interested?

There is still another important source of engineering talent for the missile/space industry which we have not yet seen our readers mention in a letter.

Firms in the industry are looking too much to fresh graduates from the universities in their quest for new scientists and engineers. They award scholarships and fellowships to promising undergraduates—and urge the government to do the same. Well and good, but these seeds take years to blossom.

There are many extremely able engineering graduates who either have left industry altogether or have been working in branches of industry where the experience is not applicable in the missile/space field.

When these men try to get into missile/space work, they find a barrier erected in addition to age: they lack appropriate experience.

Recently, an experienced engineer of our acquaintance who has an advanced degree in aeronautics and who was graduated with honors applied to the National Aeronautics and Space Administration for a technical post.

His experience coincided with that of the man who was looking for an assistant. The NASA engineer turned down our friend, explaining, "We're all in the same boat you are, trying to update our knowledge. What we need is a youngster out of school who has taken the latest courses."

We're sure this is not an isolated case, although the candor of the NASA engineer is refreshing.

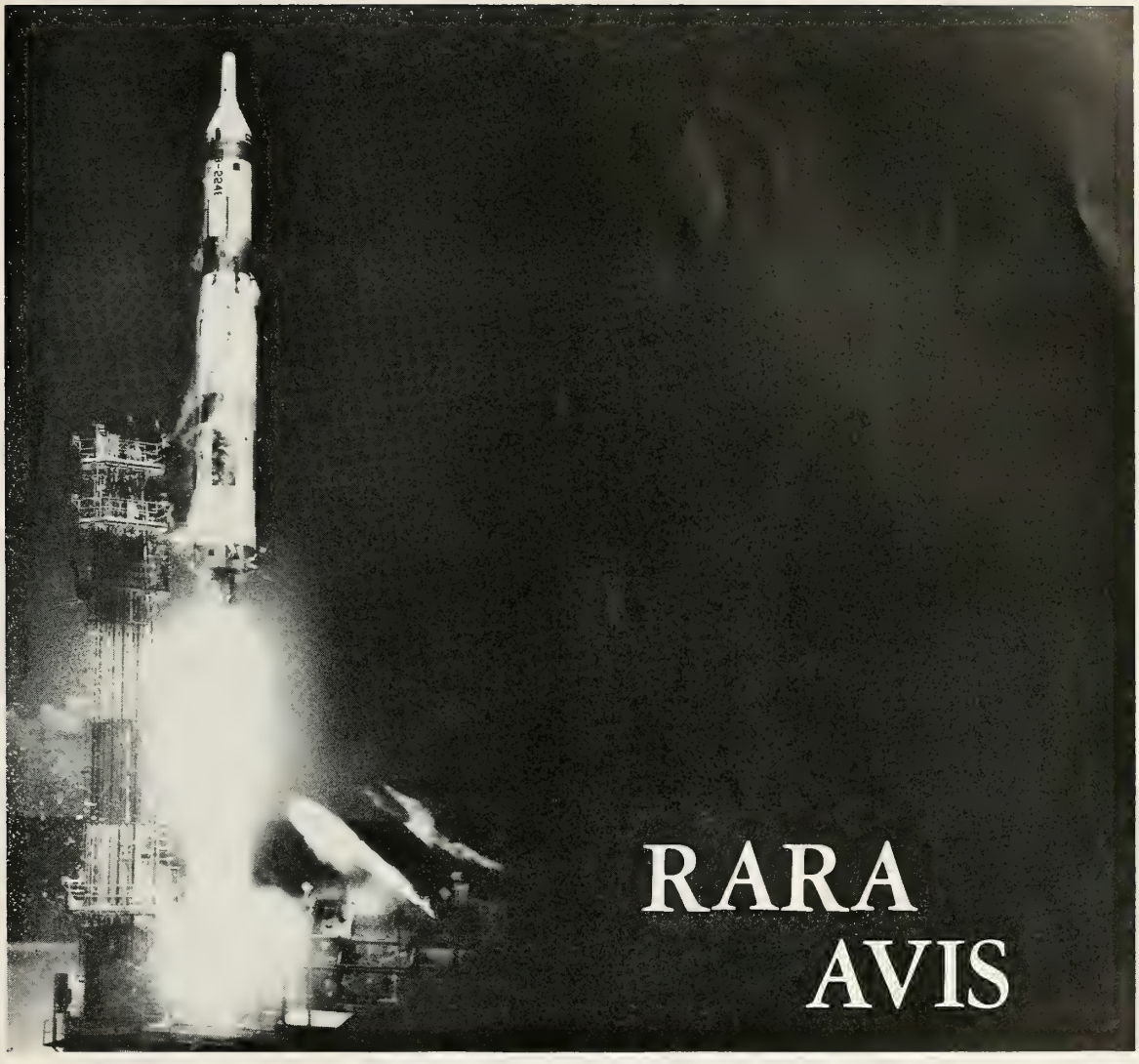
But we would like to pose this question: Which takes the most time and is the most expensive—training a youngster from scratch through a four-year engineering institution or providing the relatively brief retraining in the form of refresher courses which could make an experienced engineer a valuable asset to the Space Age?

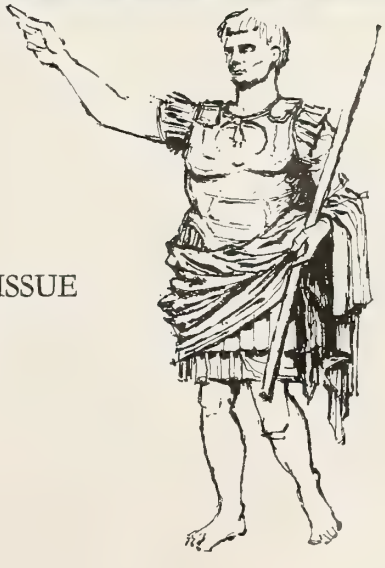
WE THINK THE ANSWER is obvious, if we are serious about whipping the engineering shortage. The Space Age is considered by too many to be the prerogative of the young. The San Diego engineer whose wife wrote to us is considered "old" at 39. We might point out that astronaut John Glenn is 40.

Unlike many other fields—such as medicine, law and journalism—engineering is one in which maturity seems to count for little. Certainly, there are problems in retraining older men. For one thing, a man with family responsibilities cannot be paid the same low salary as an interning engineer.

But the government and industry should work out a program for retraining these experienced engineers. They can be just as valuable to us as the eager youths with the fresh Ph.D.'s.

William J. Coughlin





a rare bird indeed . . .

MISSILES AND ROCKETS
SECOND ANNUAL
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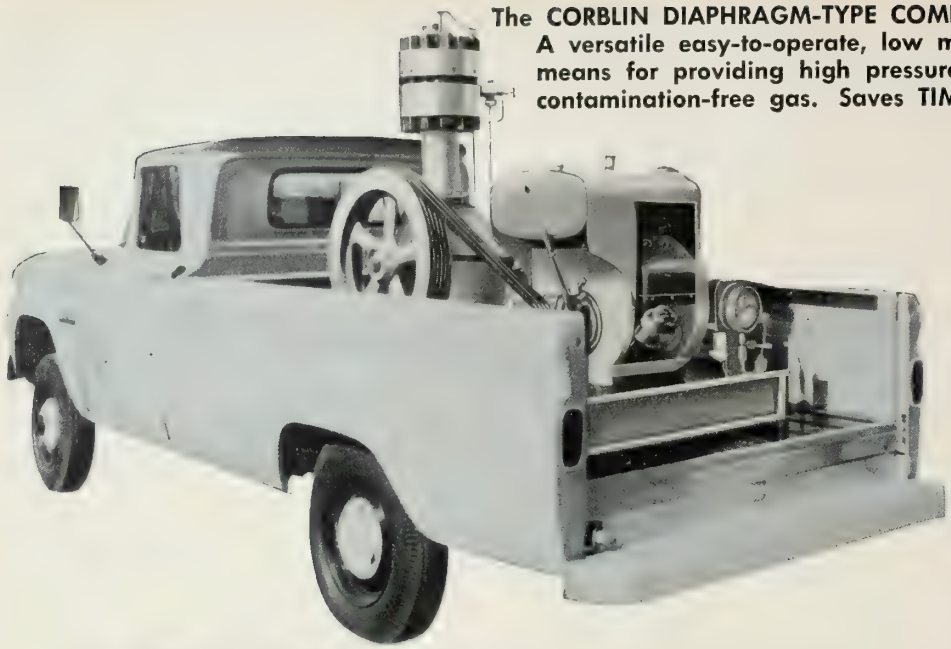

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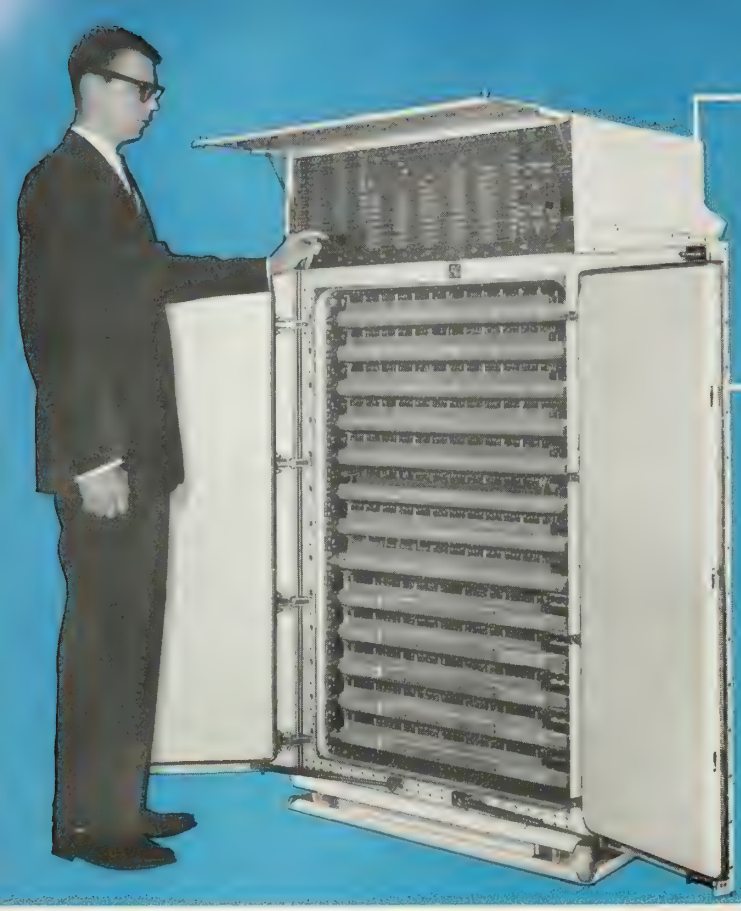

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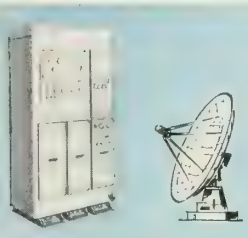

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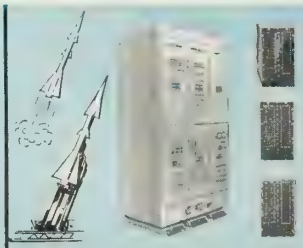

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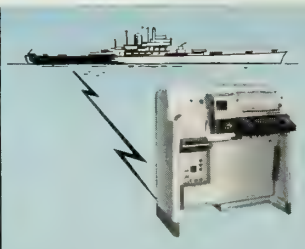

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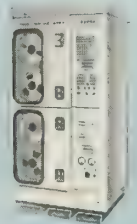

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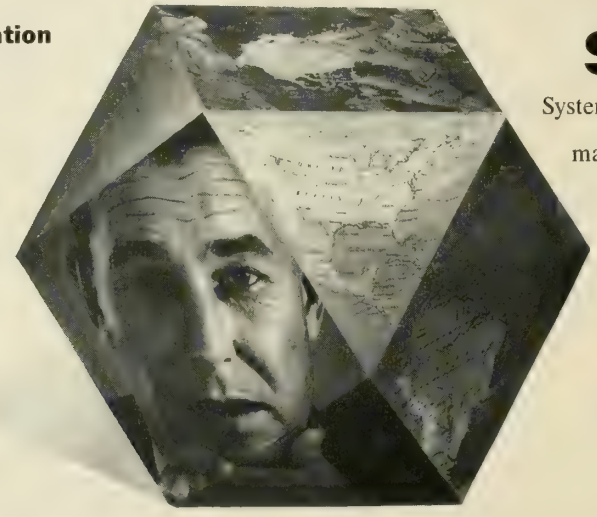

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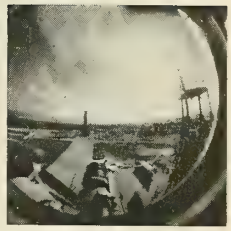
THE COVER

Astronaut John Glenn will have this periscope view of the ground before taking off in his MA-6 capsule. Camera equipment for the capsule was produced by D. B. Milliken Co. of Arcadia, Calif.



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Scientist/Engineer Shortage

To the Editor:

I have just read your article, "Scientist/Engineer Shortage Worsens" (by Heather M. David, M/R, Jan. 1, p. 12). As an engineering student very much interested in the missile field, I have a great deal at stake in the engineering profession and where it is going.

Mrs. David states that NASA is quite concerned over the decrease in engineering enrollment and graduates in the past few years—an understandable situation, since they are feeling the pinch. A few theories were presented, but these were only theories. May I suggest that if you wish to get to the bottom of this, why not ask prospective college students if they intend to enter the field of engineering—and if not, why? This could be done by sending a brief questionnaire to a number of variously located high schools. If anything is to be done about a problem, the problem must first be understood.

If you should find merit in this suggestion, may I be the first to add my comments.

The only reason I am in the college of engineering rather than physics is that I could financially afford no more than four years of college. I am not interested in physics because of the glamour associated with it, but because I have always enjoyed research. I must agree, however, with the educators who forward the belief that students are turning away from engineering because of the difficult curriculums to be encountered. In mechanical engineering, the second, third and fourth semesters at Washington State University, 19.5 hours is considered a normal load. In most other fields, above 17 hours is considered an overload requiring special permission from the registrar.

There is another problem: Money. A number of potential engineers drop out each semester because they haven't the money to continue. This definitely should never happen, especially when there is a shortage of engineers. A money shortage may have many causes, but one major one is the lack of high-paying summer jobs. I can speak from experience on this topic. Last summer I drove a pea truck in harvest, with a pay rate of $1.00/hr. You can imagine how I felt when I received my $80 pay check for two weeks' work. When harvest was finished, the only job I could find was forest firefighting.

I felt lucky to have those jobs. I had gone to the employment bureau on campus to talk to representatives of the various companies in the missile field. All except one gave me only enough time to tell me that they had no summer employment available. Only a single representative from GE looked into the matter further. Needless to say, he found nothing. I know of quite a few other students to whom the same thing has happened.

I feel that on-the-job training can be just as important as school. Why must we undergraduate students waste our time on pick and shovel jobs? I would give up almost anything to go Canaveral, or Huntsville, or Pt. Mugu to work on a job where I would be learning something and earning money to complete my education. Is it any wonder that engineering does not seem attractive to the prospects? It has nothing to offer to the undergraduate. Most fields don't. Let's change this in engineering. To attract it must be attractive.

Alvah T. Strickland
Pullman, Wash.

To the Editor:

Your article was read with interest. . . . You refer to a "National Science Foundation" study just released. What is the title of this study and is it available to the public? Does this study cover the NASA statistics you make reference to?

I. Lublin, Senior Engineer
Research Department
ARMA Division
American Bosch Arma Corp.
Garden City, L. I., N. Y.

To the Editor:

Could you supply me with the bibliography used in this article? I am very interested in this same problem from the contractor's point of view.

Edmund Morrison
Corporate Economics Staff
The Boeing Company
Seattle

The National Science Foundation study referred to is "The Long-Range Demand for Scientific and Technical Personnel," NSF 61-65. It is available from the publications office of the NSF in Washington, D.C. The statistics on NASA were gathered through interviews with Robert Lacklan, Director of Personnel, and Dr. Allen Gamble of that office. Statistics were also taken from "Estimates of Engineering Enrollments and Degrees," (an unofficial survey) by Henry H. Armsby, specialist for Curriculum Patterns in Engineering Education, Division of Higher Education, U. S. Office of Education; "Freshman Engineering Enrollment," (a special survey report) by Engineering Manpower Commission, Engineers Joint Council, 345 East 47th St., New York 17, N. Y.; and

"Investing in Scientific Progress," National Science Foundation, NSF 61-27.—Ed.

To the Editor:

I read (the article) with interest. I particularly noted the Salary Comparisons, Professional Personnel chart, and would like very much to know if you could advise me of the source or basis for the salaries shown in the Industry Rate column.

D. A. Lederer, Jr.
Personnel Manager
The Rand Corp.
Santa Monica, Calif.

The industry equivalents of Civil Service Grades 5 through 15 came from the most recent Bureau of Labor Statistics Survey of Engineers. The higher grades were secured from a joint Bureau of Labor Statistics and Civil Service Commission survey of executive salaries in 22 leading industrial companies.—Ed.

Sensor Accomplishment

To the Editor:

I was sorry to see that your article, "Sensors Function Well in Monkeys" (M/R, Jan. 15, p. 17), makes no mention of the fact that Spacelabs Inc. developed and surgically implanted the internal physiological system described.

Inasmuch as this concept was originally demonstrated by our medical-engineering staff in 1959, we feel it only fair that credit be given to their imagination and foresight, which made the flight possible.

James Reeves
Executive Vice President
Spacelabs Inc.
Van Nuys, Calif.

M/R much regrets that credit to Spacelabs Inc. was inadvertently dropped in the copy-handling process. The company was indeed responsible for the entire sensing system. Another name disappeared with the same elusive paragraph—Wyle Laboratories, on whose equipment environmental and centrifuge testing was done.—Ed.

Industry Patent Policy

To the Editor:

I read your Jan. 8 editorial, "Stifling the 'One Human Asset'," with considerable personal interest. Although I agree in principle with the ideas that you promoted, I find it difficult to muster any criticism of the approach taken by government.

As I recall, before I came to work in government service every "private industry" with which I was associated required each engineer, scientist or technician to sign away title to patent rights developed under company-sponsored research.

When the "National Inventions Act" specifies the right of government to titles of all patents developed by private industry under government research and development contracts, it seems to me that this is simply putting the shoe on another foot.

J. L. Townsend
Guided Missile Equip. Spec.
Raritan Arsenal
Metuchen, N. J.

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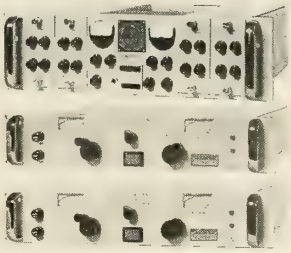

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Accepts 1, 2, 4 inputs.
Input Impedance 50 ohms.
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30-110 mc, 5 db;
90-260 mc, 6 db.

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495-1000 mc, 12 db.

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POWER.....115/230 v—50-400 cycles.

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Today OGO hovers above a crater on earth

Soon a new space chamber 30 feet in diameter will fill this deepening bowl of earth. Here OGO (NASA's Orbiting Geophysical Observatory) will be subjected to conditions of solar heating, vacuum, and vehicle radiation to the cold of outer space. The new space chamber will be the sixth at STL. It will enable engineers and scientists working on OGO, Vela Hotel and other STL projects to test large, complete spacecraft as well as major subsystems. And along with other advanced facilities at STL's Space Technology Center, it will provide unusual scope for engineers and scientists to verify and apply new techniques in design, development and fabrication of spacecraft. STL's expanding space programs have created new opportunities for engineers and scientists in the following fields: Aerodynamics, spacecraft heat transfer; Communication Systems; Electronic Ground Systems; Power Systems; Propellant Utilization; Propulsion Controls; Reentry Body Evaluation; Systems Analysis; Thermal Radiation; and Trajectory Analysis. All qualified applicants are invited to write Dr. R. C. Potter, Manager of Professional Placement and Development, for opportunities with STL in Southern California or at Cape Canaveral. STL is an equal opportunity employer.

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The Countdown

WASHINGTON

Decision Near on NATO H-Missiles

The time for a decision on arming NATO European troops, including West Germans, with nuclear-tipped missiles is almost past. Martin *Matadors* already in the hands of West German troops have a dual warhead capability. And by early next year the Germans are expected to receive their first *Pershings*—missiles so far designed only to carry nuclear warheads. Agitation within NATO for a decision is mounting sharply.

Polaris Report Card

Here is how the *Polaris* fleet's ready-to-fight record looks more than a year after the first *Polaris* submarines went on patrol: The subs on station have been ready to launch all of their missiles—16 per ship—95% of the time; each sub has been ready to launch 15 of its missiles 99.9% of the time. Meantime, the last 10 Lockheed *Polarises* launched from submerged subs have been scored "completely successful."

Congress and NASA: Round One

The House Space Committee expects to start digging into NASA's $3.7-billion authorization bill late this month amid rumblings that the people "back home" aren't sold on going to the moon. There are also reports from the Hill that some congressmen feel NASA's dollar estimates were "picked out of the air." These objections are expected to come up during hearings by four subcommittees. The Senate Space Committee, meantime, is readying hearings on the Administration's ComSat plan (see p. 17).

First OSO Readied

The first *OSO* satellite—NASA's *Orbiting Solar Observatory*—is scheduled to be launched from Cape Canaveral this month. The launching originally was set for late last year. However, the program slipped because an experiment being prepared for the satellite by the University of Colorado was not ready.

Navy Drives for Full Magazines

The Navy missile procurement goal for calendar 1962 is to fill the magazines of all missile-launching ships of all classes in the Fleet by next December. Total missile launching ships in the Navy to date: 30. Total planned by next December: 39. The figure for December includes a total of nine *Polaris* subs.

Nike Strength Around the World

The latest figures on worldwide deployment of nine-launcher batteries of Western Electric *Nike-Ajax* and *Nike-Hercules* batteries show there are more than 250 in continental United States, more than 50 overseas manned by U.S. forces. *Nike-Hercules* batteries now are estimated to number more than 250. All *Ajax* batteries are scheduled to be converted to second-generation *Hercules* missiles this year.

INDUSTRY

Motorola Gets Key Nod

NASA has tapped Motorola for the major job of developing the Goddard range and rate tracking system. Significance behind the $3-million contract: The system will play a big role in NASA's future satellite tracking in near space and deep space. The Motorola equipment will be mounted in small lightweight trailers so that it can be moved easily to various locations.

R&D Intelligence

Lockheed Missiles & Space Co. is developing polar-orbiting satellite instrumentation for the Office of Naval Research to investigate what causes the aurora borealis . . . Scientists at Oak Ridge Biology Labs believe photosynthetic changes in bacteria may be electronically activated . . . Yttrium iron garnet has been found by Bell Telephone Labs to be exceptionally efficient as both a transmitter and transducer of acoustic energy . . . RCA has come up with a solid ceramic circuit about one-third the size of an aspirin tablet that is mass-producible.

MRBM Gets Moving

The Air Force Systems Command has assigned responsibility for developing the mobile land-sea *MRBM* to its Ballistic Systems Division. Requests for proposals will be solicited later this month.

INTERNATIONAL

Blue Steel Price Rockets

The cost of developing the Avro *Blue Steel* is reported to have run some 400% higher than the original estimate. The R&D pricetag on the air-to-surface missile: $170 million. The original estimate made in 1955: $35 million.

Black Prince Fuel Studies

Three possible fuel combinations are being studied by Boelkow and Entwicklungsring Nord for use in the *Black Prince*—third stage of the European *Blue Streak* space booster. The three combinations: Fluorine and hydrogen, UDMH and N_2O_2, and hydrogen and oxygen.

Royal Navy Buys Bullpups

The Royal Navy is ordering 1000 Martin *Bullpup* air-to-surface missiles for arming Buccaneer strike aircraft. The *Bullpups* are expected to be manufactured in Britain. Hawker-Siddeley is considered to be the manufacturer. The RAF may buy *Bullpups*, but so far it has ordered only *Nord AS-30*'s.

Manned Mercury Shot Faces Further Delay

The first U.S. attempt to put an astronaut into orbit continues to slip.

NASA has rescheduled the *MA-6* flight for on earlier than Feb. 14—a one day postponement from the previously announced Feb. 13 launch date.

Space agency officials said that results of a check on the *Atlas* booster's fuel system may force additional delays. This could push the launch into the week of Feb. 19.

Meanwhile, Air Force officers denied that the *Atlas's* fuel system problems would affect U.S. ICBM capability.

The fuel system leak occurred when high-grade kerosene leaked into an insulated bulkhead in the *Atlas* which will boost *MA-6*.

Strategic Air Commander Gen. Thomas S. Power said that "the problem referred to does not affect SAC's *Atlas* missile capability."

He cited two reasons:

1. *Atlas* missiles are fueled only 15 minutes before launch and daily checks would reveal any deterioration in the bulkhead.

2. Of 54 *Atlas* missiles now combat-ready, only 27 have bulkheads like that in the *MA-6* booster.

In another development, Lloyds of London announced that it had been asked to insure the life of Astronaut John Glenn.

The firm said that the policy worth $95,200 was taken out with an American insurance firm which asked Lloyd's to reinsure part of the risk.

Shots of the Week

The Army racked up two more successes with the Western Electric *Nike-Zeus*.

A two-stage bird passed a flight test from an underground launcher Feb. 7 at White Sands Missile Range and on Feb. 1, also at WSMR, a three-stage *Zeus* went through a guided maneuver at "relatively low" altitude.

The Air Force on Feb. 1 scored with a Boeing *Bomarc A* on a QF-104 drone aircraft over the Eglin Gulf Test Range and also launched a North American *Hound Dog* from a B-52 over WSMR.

U.S. Decision on H-Bomb Tests Scheduled To Be Made By March

President Kennedy has promised the world to announce within a month his decision on whether the U.S. will renew nuclear testing in the atmosphere.

Kennedy made the announcement at a news conference Feb. 7—less than a week after Russia detonated its first reported underground nuclear test at the Soviet Semipalatinsk Testing Site in Central Asia.

The underground test—reported by the AEC to have taken place Feb. 2—is believed to have topped at least 20 kilotons. The Russians apparently made no attempt to hide the nuclear explosion by muffling it.

The nuclear test was the first in Russia since the end of the big Soviet test series Nov. 4. All of the last series were in the atmosphere.

Red Missile Sub Threat Seen To Be Growing Rapidly

Top U.S. Navy officials are renewing warnings to Congress and the Administration that the threat to U.S. coastal areas from Soviet missile subs is growing month by month.

Adm. George W. Anderson, Chief of Naval Operations, told the Senate Armed Services Committee that the Russian missile sub fleet poses a "positive threat" and that threat is expanding.

"As of now their capabilities are limited, but there is no reason to doubt that before long . . . they will have weapons capable of greatly exceeding their 350-mile range. . ."

However, officials note that even the range of 350 miles with which the Soviet sub-launched missiles are now credited, much of America's metropolitan heart is vulnerable.

The Russians have been estimated to have as many as 30 missile-launching submarines in operation—possibly five to 10 of them nuclear-powered.

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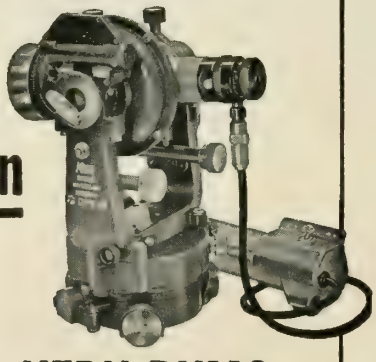

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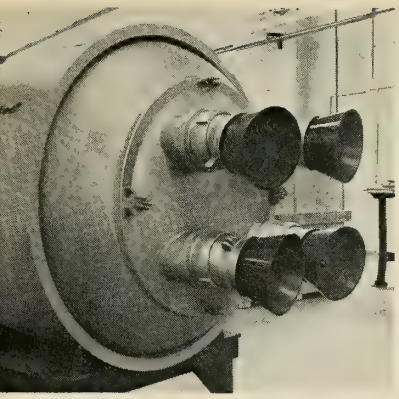


Dyna-Soar Escape Power

ACCELERATION rocket for Dyna-Soar will be built by Arde-Portland for Thiokol Chemical Corp. The contracts cover design and fabrications of case and movable nozzles. Unit will be used as primary power in B-52 drop tests and as escape engine for the glider if any malfunctions should occur during boost into orbit.

The missiles carry nuclear warheads. However, Navy experts believe the subs must surface before launching their weapons.

Rover Contractor Named

The Catalytic Construction Company of Philadelphia was named last week to build the nuclear-rocket development facilities at the AEC's Nevada Test Site.

A joint AEC-NASA announcement said the firm would be responsible for administration, coordination and inspection of the construction of facilities for the *Rover* program.

Construction includes the erection of a complex of facilities including engine and stage assembly and disassembly buildings, engine and stage test stands and various other structures.

It is expected, the announcement said, that the Catalytic Construction Co. will coordinate and supervise six to eight contracts—totaling $15,000,000—and provide the architect-engineering services required for them.

Two Vie for Mercury Tracking

NASA will negotiate with two companies to select a contractor to operate five *Mercury* tracking stations.

The firms are the Bendix Radio Division of Bendix Corp. and RCA Service Co.

The two-year contract will be worth about $10 million. It is for the operation and maintenance of stations at Bermuda; Grand Canary Is.; Kano, Nigeria; Zanzibar and Guaymas, Mex. Also included is the test and demonstration at Wallops Is., Va.

Bendix has operated these stations for about a year, and its contract will be extended until Dec. 31, 1962. The new contract covers the 1963-64 period.

The two companies were chosen from eight submitting proposals in December.

Missiles in Cuba Expected Soon by U.S.

American intelligence estimates have openly confirmed for the first time reports that Cuban Dictator Fidel Castro will soon arm his Communist Army with missiles.

The Cuban missiles are expected to be capable of striking targets both in the United States and in many nations throughout the Caribbean Area.

The official report said Castro already has 50 to 100 jet fighters, 150 to 200 medium and heavy tanks and 500 to 1000 artillery pieces.

It said that the missiles and possibly some bombers are expected to be provided by Russia in the near future.

JFK Lauds Equal Job Signers

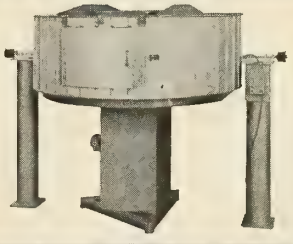
President Kennedy last week praised 31 defense contractors as they signed guarantees to provide equal job opportunities in their plants.

Twenty-one firms signed the pledge earlier.

The chief executive said dropping the bars on discrimination was "an important blow for progress . . . and the private enterprise system."

The latest guarantees were signed by: American Machine & Foundry, Bendix, Burroughs, Chrysler, Collins Radio, Continental Motors, Curtiss-Wright, Ford, Garrett Corp., General Motors, Goodyear Tire & Rubber, Grumman, Hercules Powder, IBM, International Harvester, ITT, Kaiser, McDonnell, Minneapolis-Honeywell, Newport News Shipbuilding & Dry Dock, Pan American, Philco, Raytheon, Republic Aviation, Ryan. Sanders Associates Inc., Socony Mobile, Sperry Rand, Texas Instruments, Textron Inc., and Thiokol.

Genisco offers a complete line of acceleration test equipment — standard and special models, from low speed rate-of-turn tables for gyro production to high-precision special design, electronically controlled 50-foot diameter centrifuges. Reliability of more than 100 times other rotating equipment is assured — accuracy to one part in 100,000 over range of 1.0 to 12.5 G's with 25-G maximum.



Shown above is one of Genisco's well known 931 Series centrifuges, extremely precise, electronically speed-controlled units for research and development as well as production test applications. Fixed mounting platform (25 lb. max. load), and outboard table (10 lb. max. load), with .001% allowable drift achieved through crystal-controlled oscillator for setting accuracy.

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Titanium roll-forged parts prior to welding into body-sections of Minuteman casings at Lycoming Division of the Avco Corporation.

In Minuteman second stage

Titanium rocket case reduces weight 30%, boosts rigidity and reliability

Aerojet General Corporation has selected titanium for second stage Minuteman rocket motor cases as the fastest, most economical and reliable way of reducing the inert weight of this massive part.

Light-weight titanium (density 0.163 lb./cu. in.) can be used in section sizes which prevent buckling failures. To achieve equal buckling resistance, use of steel would impose a 30% weight penalty.

Titanium is immune to atmospheric corrosion.

High strength-to-weight. Titanium alloy grade Ti-6A1-4V is heat treatable to 160,000 psi tensile strength, with elongation in the range of 10 to 15%. Its weldability and total reliability is demonstrated both in elevated temperature applications (including 7000 jet engines) and cryogenic temperature applications (including 4000 pressure vessels).

Applicable to current programs... Ample titanium mill capacity and the network of fabricators experienced in handling this grade guarantee a steady supply of parts should the program be accelerated. Since steel tooling and testing technologies are largely applicable, titanium has been introduced into the Minuteman program with no scheduling penalties.

Decreasing cost. The completed titanium cases cost slightly more than the alternate steel versions—but the differential vanishes under the impact of the 30 percent weight reduction titanium provides.

Ease of fabrication. Titanium is not as sensitive to weld porosity as steel. There is no need for pre- or post-heating of the titanium weld area.

How to use TMCA information resources . . . if you need information on titanium fabrication techniques or competent fabricators, write TMCA's Technical Service Department. Titanium can solve your weight problems.

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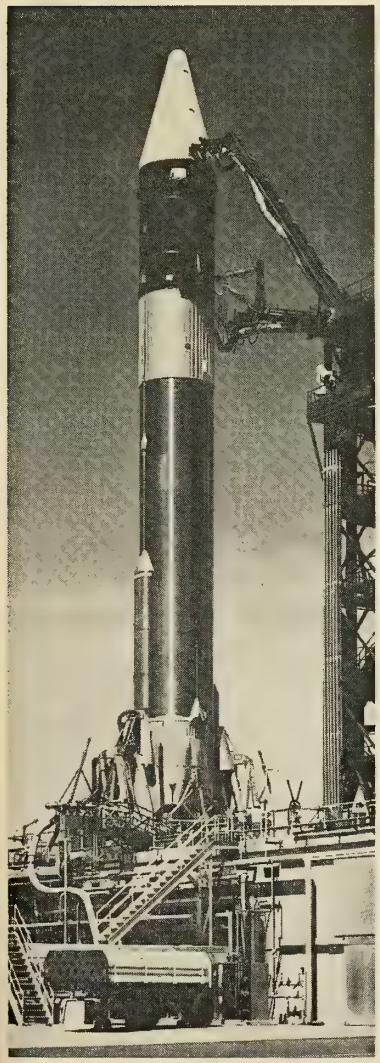
On other programs too . . .

Centaur Slippage Drag on Apollo

Eight months delay from first firing means that Surveyor shots designed to gather data on lunar surface and environment can't be made before '64 at best

by Hal Taylor



OFTEN BRIDESMAID—Centaur atop its Atlas booster at Cape Canaveral.

DELAYS IN NASA'S *Centaur* launch vehicle program are putting a big crimp in planning for the U.S. manned lunar-landing program.

Two launches of the lunar soft-landing *Surveyor* spacecraft—designed to provide needed information on the lunar surface and environment—have been pushed back one year because of *Centaur's* unavailability.

Centaur was to have flown for the first time in June, 1961. The launch date was slipped repeatedly while ignition problems were overcome. The new date this month or early in March. Delays this year have been caused by difficulties with GSE and instrumentation of the vehicle.

First scheduled to go in 1963, the moon shots have been postponed until at least 1964. This means that NASA—already heavily engaged in developing the *Apollo* spacecraft and its environmental control system—will have no detailed information on the moon until shortly before the planned lunar landing in 1967.

Other space projects have also been pushed back or scaled down because of the *Centaur* lag. These include the Army's *Advent* communications satellite and the space agency's series of interplanetary flights with the *Mariner* spacecraft.

NASA officials continue to express confidence in its liquid hydrogen-oxygen space vehicle which will be used as an upper stage on the *Atlas* and *Saturn* boosters.

• **Reassessment threat**—They deny reports that the program—into which NASA will have poured over $200 million by the end of Fiscal 1963—will be dropped. It is clear, however, that if more troubles develop during the first launches this year it may be thrown on the scrap pile.

In addition, heavy congressional criticism which is certain to crop up during hearings on NASA's programs in the next few weeks may force further evaluations of its potentialities.

There are two reasons—one which might be termed optimistic, the other pessimistic—for the continued reliance on *Centaur* by NASA and DOD officials.

—Even though it has been oft-delayed, *Centaur* is due to make its maiden trip shortly. (On paper, it is slated to go from Cape Canaveral this week, but a one- or two-week slippage is almost certain.)

—There is no upper stage now—nor will there be in the foreseeable future—which will have the thrust or capability of performing *Centaur* missions. The only similar vehicle now in existence is the *Agena B*. This, however, has a thrust of only 15,500 lbs., compared to *Centaur's* 30,000 lbs. While advanced *Agenas* are on the drawing board, none will have *Centaur's* boosting power. In addition, *Centaur* has a multiple restart capability—essential for deep orbital and interplanetary flights with unmanned scientific spacecraft.

• **No precedent**—*Centaur's* problems in the past—and to some extent at the present time—stem principally from the huge advancement in the state of the art which it represents. It is the first U.S. launch vehicle which will burn liquid hydrogen—a fuel that provides 30% greater performance than conventional liquid rocket fuel, a refined form of kerosene.

Liquid hydrogen and liquid oxygen, its other fuel component, are not hypergolic. An ignition system is required, and most of *Centaur's* problems stem from the simultaneous ignition of its two engines.

It is believed now that these problems have been solved. President Ken-

NASA Launch Vehicles

Vehicle	Stages	Propellant	Thrust (in Thousands of pounds)	Max. Dia. (Feet)	Height Less Spacecraft (Feet)	Payload (Lbs.) 345 mile orbit	Escape	Planetary	First NASA Launch
REDSTONE	1. Redstone	LOX/ALCH*****	78	5.9	83	Ballistic	....	....	1960
SCOUT	1. Algol (Aerojet Senior) 2. Castor (XN-33-20) 3. Antares (X-254) 4. Altair (X-248)	Solid Solid Solid Solid	98 48 13.6 2.8	3.3	65	150	....	....	7/1/60
DELTA	1. Thor (DM-19) 2. AJ10-118 (Improved AJ10-42) 3. Altair (X248)	LOX/RP* WIFNA/UDMH** Solid	150 7.7 2.8	8.8	77	500	60	....	5/13/60
THOR-AGENA B	1. Thor 2. Agena B	LOX/RP* IRFNA/UDMH***	165 16	8	80	1,600	....	....	1962
ATLAS D	1. Atlas D	LOX/RP*	367	10	72	2,700	....	....	1960
ATLAS-AGENA B	1. Atlas D 2. Atlas D Sustainer 3. Agena B	LOX/RP* LOX/RP* IRFNA/UDMH**	367 80 16	10	98	5,000	750	400	1961
TITAN II	1. LR-87 2. LR-91	Storable Liquids Storable Liquids	430 100	10	90	N/A	N/A	N/A	1963
CENTAUR	1. Atlas D 2. Atlas D Sustainer 3. Centaur	LOX/RP* LOX/RP* LOX/H_2****	367 80 30	10	105	8,500	2,300	1,300	1961
SATURN C-1	1. S-1 (8 Cluster H-1) 2. S-IV (6 Cluster A-3)	LOX/RP* LOX/H_2****	1,500 90	21.6	125	20,000	....	....	1 stage 1961 2 stage 1963
ADVANCED SATURN	1. S-IB (5 Cluster F-1) 2. S-II (5 Cluster J-2) 3. S-IVB (One J-2)	LOX/RP/* LOX/H_2**** LOX/H_2****	7,500 1,000 200	33	275	200,000	85,000	60,000	1965
NOVA	1. N-1 (8 Cluster F-1) 2. N-II (4 Cluster M-1) 3. N-III (One J-2)	LOX/RP* LOX/H_2**** LOX/H_2****	12,000 4,800 200	50	280	350,000	150,000	1000,00	....

*Liquid Oxygen/Kerosene-like Hydrocarbon
**White Fuming Nitric Acid/Unsymmetrical Dimethylhydrazine
***Inhibited Red Fuming Nitric Acid/Unsymmetrical Dimethylhydrazine
****Liquid Oxygen/Liquid Hydrogen
*****Liquid Oxygen/Alcohol
N/A Not Available

nedy in his report to Congress on U.S. space activities said, "During 1961, a *Centaur* ignition fault that had caused a series of explosions on the test stand was corrected.

"Recent static runs give assurance that the engine is now qualified for flight testing, for which final preparations were under way at Cape Canaveral as the year ended", the President said.

• **Setbacks**—Nevertheless, the first launch of the vehicle slipped into 1962. As space agency officials prepared for a launch in the near future, they reported that most of the current difficulties are minor.

They cited completion of instrumentation wiring, and slight GSE and vehicle problems.

It is true, however, that the delay has forced NASA to curtail the *Centaur* test program over the next two years, at least.

Only four launches have been scheduled for 1962. Earlier planning called for six shots. In addition, at least three and probably all four of the launches this year will have no payload.

Instead, each will carry only TV cameras and heavy instrumentation.

In 1963, only three shots are on the schedule, but each is now slated to carry a payload. Two of the launches will boost the *Advent* communications satellite into orbit. The other will be the first *Centaur*-boosted *Mariner* shot.

Two *Mariner* spacecraft, designed to go into a long interplanetary trajectory which would carry them into the vicinity of Venus, were originally scheduled for mid-August this year. Because of the *Centaur's* problem, a switch to the *Agena B* was necessitated. This cut down the spacecraft's size from over 1000 lbs. to 750. The *Advent* satellites scheduled for this year will also use the *Atlas-Agena B* combination.

No payload requirements for *Centaur* are now on NASA's 1964 flight schedule. Under study, however, are the *Surveyor* launches and two *Mariner* probes to Mars and Venus. If the *Centaur* is not ready, it is likely that these will either be scaled down so that the *Agena B* can be used or that a *Saturn* launch vehicle will be substituted. The latter 1.5-million-lb.-thrust booster is expected to become operational in 1964.

• **Key to Apollo's progress** — The importance of *Surveyor* to the *Apollo* program is unquestioned. Following the *Ranger* spacecraft lunar hard-landing series, it is designed to soft-land on the moon.

The experiments and the information they will provide includes:

—Soon after the landing, a drill will be deployed which will break the lunar surface and distribute it to various instruments for analysis.

—A one-hour TV survey will be carried out by X-ray fluorescence spectrometer, a neutron activator, a mass spectrometer and a gas chromatograph for detection of organic molecules.

—Surface physical analysis will be conducted by a densitometer, thermal and electrical conductivity instruments, sound speed measurements, and the television systems.

—Local subsurface properties to a depth of 5 ft. will be analyzed by the X-ray spectrometer and neutron activation instrument in the hole made by the drill.

—Lunar structure will be examined by a three-axis seismometer and a gravimeter. ⌘

Satellite Engineering Course Planned

Pilot course to be set up under agreement with NASA and directed by Aero Geo Astro may help solve critical problems

A COURSE IN the practical engineering aspects of space satellites will be developed by Texas A&M College under an agreement with the National Aeronautics and Space Administration.

Texas A&M is in the process of organizing the course with the aid of Aero Geo Astro Corp. Dr. E. A. Wolff, staff consultant with A.G.A., will direct the course.

Rep. O. E. Teague (D-Tex.), Chairman of the House Space Committee's Subcommittee on Manned Space Flight, said the course ". . . could be a forerunner of a greatly expanded program by NASA aimed at providing intensive training in space technology for engineering graduates entering the space field."

The course consists of nine two-week units covering environment, electronic components, fabrication techniques, detectors and sensors, orientation and control, power sources, telemetry, structures, and spacecraft integration.

K. S. Kelleher, president of A.G.A., an Alexandria, Va., firm, said the prime objective will be to acquaint the students with the basic hardware problems and techniques involved in the construction of a payload. Equipment, guidance and some visiting lecturers will be supplied under a $50,000 contract Texas A&M is negotiating with A.G.A.

NASA is extremely interested in this pilot effort and hopes to tie it in with the current recruitment drive. The course will run through the current semester at A&M, with students drawn from fourth-year undergraduates, instructors and graduate students.

• **Broad effect** — The potential is much greater than the original pilot course indicates. NASA feels there is a vast amount of technical knowledge going to waste in U.S. colleges and universities.

A large number of graduate programs are in being, but very few of these are designed to train engineers in the highly special skills involved in space technology.

Indications of this weakness have shown up in the design of many space experiments aimed at securing specific information during a flight. Some of these simply fell apart during such standard environmental checks as vibration.

The hard-won experience gained by industry and government teams has not filtered back to the academic stages —with the result that engineers fresh from school cannot be efficiently utilized. And the job of training them simply pulls more highly trained personnel away from specific program tasks.

The A&M effort is the beginning of what may prove to be a solution.

Kelleher says the program might easily evolve to the point where industrial firms will be sending their engineers for additional training, refresher courses or just plain familiarizing.

Aero Geo Astro will be applying the results of extensive experience in space vehicle problems. The firm, founded in 1958, is currently at a $6-million level, with most of its output going into NASA and Navy projects.

Sales includes about 40% proprietary items in flight telemetry, command receivers, power supplies, antennas and radio transponders. A.G.A. has participated in such programs as *Mariner A, TRAAC, Imp, Atlas Able I, Transit, Tiros III, Echo A-12, OGO, EOGO, POGO, OAO* and some military systems including *Bomarc* and *Polaris*.

Texas A&M will be receiving a total of about $250,000. Some of this will go for specific graduate experiments and basic research. About 30% will finance the pilot course, which includes both the A.G.A. contract and involvement of A&M facilities. ⁂

Titan II Arrives at the Cape

SHROUDED in its traveling "jacket," a Martin Titan II makes its first appearance at Cape Canaveral. The big Air Force ICBM isn't expected to be unveiled to the public until it is launched—probably in mid-March.

U.S. May Put More Wraps on DOD Satellites

Proposed Administration plan would identify most military satellites only by Greek letters; fear of Red attack seen

THE KENNEDY Administration is weighing a new plan designed to obscure military satellite and spacecraft launchings in far greater secrecy.

To date no final orders are reported to have been issued to the military services by the Defense Department. However, the issuing of the orders is understood to have been delayed only because of some strong internal service opposition.

In general, the proposed order would direct the military services to identify most of their satellites only by the Greek letters and dates that have always been assigned to each object placed in orbit.

For example, when the *Samos II* reconnaissance satellite was launched into orbit on Jan. 31, 1961, it was officially named *1961 Alpha 1* because it was the first satellite to be placed in orbit last year.

Under the proposed plan, *Samos II* would never be identified in any other way than as *1961 Alpha 1*. Very little or no pre-launching information would be released.

The Administration has been moving in this direction for some time in connection with military satellite launchings. The word *Samos* itself has fallen under a ban. The word *Midas*, code name for the early warning satellite system under development, has generally been expected to be next.

The trend indicates the Administration's growing concern that Russia may decide to take offensive action against U.S. military satellites—action that is generally considered to be technically feasible today.

• **Aware of Greeks**—On the other hand, critics of the Administration's proposal contend that the use of Greek letters is scant protection for military satellites. The critics point out that Russian space trackers can pin-point the orbits of unidentified satellites labelled only with Greek letters just as well as they can those with more explicit names. Since NASA would continue to identify its satellites by both letters and names, the military satellites would be rather evident.

Finally, the critics content that Russia has drawn no distinction between many so-called "peaceful" satellites such as the *Tiros* weather satellites, and "military" satellites such as *Midas*.

• **Background**—One important factor involved in the satellite-naming business is the U.S. proposal in the United Nations urging that all nation's identify satellite launchings.

The proposal — approved by the General Assembly's Political Committee last December—appeared to be in direct conflict with the Administration's policy on various recent satellite shots.

In two instances late last year, the Air Force launched unidentified satellites from Pt. Arguello, Calif. Each time the Air Force was forbidden to disclose the identity of the satellite or whether the satellite went into orbit. Both satellites were believed to have been *Samoses*.

The proposed new plan would modify the procedure used in these cases only to the extent that the satellites if placed in orbit would receive Greek letter names. Some vague descriptive phrase such as "research and development" also might be added.

Another important factor involved in satellite identification is where Russia stands in the development of a satellite inspection system designed to determine the nature of satellites by other satellites. Development of such a system by Russia would make any program of secrecy by code letter obsolete.

Technique Makes Inflatable Structures Self-rigidizing

INFLATABLE space structures can be made self-rigidizing through a process being developed at Westinghouse Electric Corp.

The vacuum of space is used to remove a softening agent through the mechanism of an extracting liquid. Westinghouse scientists are experimenting with fiberglass fabrics as the material base. Special coating formulas are added to form a barrier in the porous surface, permitting inflation.

These coatings also contain a plasticizer which acts as a softening agent and allows the structure to be compactly folded. After erection, the extracting liquid evaporates into space, taking the plasticizer with it. The remaining coating composition provides the structural strength.

Applications include communications antennas or solar reflectors. The work is a joint project with the Air Force's Aeronautical Systems Division.

INFLATION in a vacuum chamber is caused by the vapors evaporating from the inside of the sphere. The structure stiffens within a few hours.

CUTTING a circular section from the sphere leaves the unit structurally intact. Westinghouse is also studying the concept's load-carrying capabilities.

JFK's ComSat Bill Looks Like Winner

Proposal for private operation under public ownership expected to win support of majority of membership in both houses

QUICK congressional approval is being forecast for Kennedy Administration legislation to establish a communications satellite system under a plan providing broad public ownership.

The measure sent to Capitol Hill last week would set up a private profit-making corporation to operate the ComSat system. There would be safeguards to prevent any one firm or individual from getting monopolistic control.

President Kennedy in a message hailed his proposal as one of "immense long-range importance."

The bill is tailored along the lines of a plan offered by missile/space industry opponents of a Federal Communications Commission proposal to permit international communications carriers to operate and control ComSats.

Two types of common stock would be offered for sale under the Kennedy bill. Class A—with a total capitalization of $1 billion—would be sold to the general public and have voting rights and earn dividends. Class B stock would be open for sale only to communication carriers, have no voting rights and earn no dividends.

To prevent monopoly control, the legislation provides that no individual can own more than 15% of the total Class A stock. In addition, individual stockholders and firms can vote for only two of the 9-to-13-member Board of Directors.

• **Broad appeal**—Dr. Edward C. Welsh, executive secretary of the National Space Council and author of the bill, said ". . . it ought to get a great deal of support."

He cited two reasons:

—Balanced approach—"It provides for all the advantages of private enterprise while allowing the government to exercise control sufficient to protect both the national and international interests."

—Minority opposition—"Only a minority of congressmen and senators will oppose it because they support government ownership of the system, and a few more will oppose it because they favor ownership by communications carriers only."

Dr. Welsh's views were echoed by other Administration officials. They added that the measure will be even more palatable because it permits communication carriers to charge some of their investment in the corporation against the companies' rate base. This, they claimed, was one of the main reasons why communication carriers wanted ownership restricted to themselves.

There were also indications from Congress itself that the legislation will receive a hospitable reception. The Senate Space Committee scheduled public hearings on the bill for Feb. 26. Committee Chairman Robert Kerr (D-Okla.) has already introduced legislation restricting ownership to communication carriers. He said, however, that he is "not committed to support of the bill, and willing to listen to other versions."

On the House side, Space Committee Chairman Rep. George Miller (D-Calif.) has introduced similar legislation, but committee sources said it is simply a vehicle to give the committee sufficient jurisdiction to hold hearings.

• **Trouble spots** — However, congressional sources say there are two sections in the bill which could run into trouble. One of these provides that the President be empowered to designate incorporators who will arrange for the initial stock offering. Many congressmen are likely to feel that this authority should be vested in the Federal Communications Commission.

The other section establishes a Director of Telecommunications Planning —a new post to be established in the Office of Emergency planning which will coordinate and manage the telecommunications resources of the country.

This no doubt will raise the ire of congressmen who oppose further Federal control of business.

But the Administration bill also has two other attractive features:

—Its call for the public sale of all stock and a total capitalization of over $1 billion makes it almost certain that no Federal subsidy will be necessary.

—Most congressmen are aware that communication satellite development is the one area in space where the U.S. has an apparent lead over Russia. They are unlikely to oppose the system, because this would kill all U.S. chances of reaping the prestige which will come to the first country which establishes a world-wide system of satellite traffic.

• **Ground rules**—Other major provisions of the Administration bill:

—One million shares of Class A stock will be issued at a price of $1000 each. No price was set for the 10,000 shares of class B stock, but it will probably be pegged high to discourage excess purchases.

—The Federal Communications Commission can require any communication carrier which owns Class A or Class B stock to sell a number of shares to other communication carriers.

—The corporation will plan, initiate, construct, own, manage, and operate itself or in conjunction with foreign governments or business entities a commercial satellite system.

—The corporation shall not enter into negotiations with any foreign government or international agency. The Department of State will conduct or supervise such negotiations and will approve or disapprove all such agreements.

—NASA will assist the corporation in its research and development program and furnish to it, on a reimbursable basis, satellite launching and associated services required for establishment, operation and maintenance. ⌗

HOW 6 TRANSISTORS CAN WORK 7 TIMES HARDER WITH ONLY HALF TRYING

(a report from Delco Radio)

Sound like a riddle? Well, it was . . . almost. Here's the story.

Delco Radio engineers wanted to build a precision static inverter that was smaller, simpler, lighter, more economical and considerably more powerful than previous models.

Research hit on the idea of current feedback. Following this principle, the engineers designed an amazing inverter using only 6 transistors. Transistor utilization is stepped up 7 times, yet the transistors work at less than 50% of their capacity, run cooler, last longer.

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This new Delco 250 VA power supply converts 28 volts DC to 115 volts, 400 cps. Its circuits are a model of simplicity.

The unit is designed for continuous full-load operation at 71 degrees C. still air, yet weighs only 10 lbs., measures 6¼" x 7⅜" x 5". A minimum of components assures extra-high reliability.

The 250 VA Static Inverter is practical hardware today, awaiting your inquiry. Delco Radio may be able to solve your problem in miniaturization, modules, inverters or converters, too. Write to Delco Radio Military Sales Department, Kokomo, Indiana.

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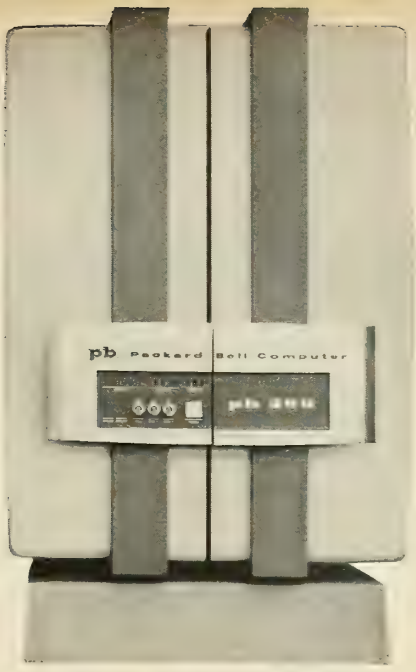

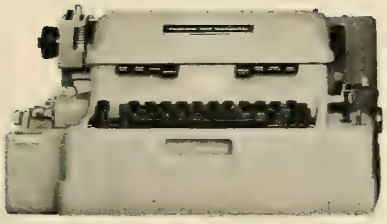

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Opportunities for:

Aerospace Vehicles Engineers

The Aerospace Vehicles Laboratory of the Space Systems Division has openings for nearly one hundred engineers who have experience in stress, structures, propulsion, mechanisms, control systems, equipment installation or heat transfer which can be applied to advanced aerospace weapons systems or vehicles. The Aerospace Laboratory is concerned, as a result of SURVEYOR and other contracts, with lunar and space exploration, air to air missiles and ICBM defense systems. The openings are for both junior and senior mechanical engineers, electronic engineers, physicists and aeronautical engineers. Some of the openings are described below:

Structures

Senior Dynamicist. Must be capable of performing advanced analysis in structural mechanics. Will be required to calculate response of complex elastic systems to various dynamic inputs including random excitation. Must be capable of original work in developing advanced analytical techniques.

Loads Analyst. To establish structural design criteria for advanced missiles and spacecraft. Should be capable of determining external airload and inertial force distributions.

Reliability Analyst. To perform statistical analysis of structural loads and strength properties for the purpose of establishing structural reliability criteria on a probability basis.

Stress Analyst. To perform advanced stress analysis of complex and redundant missile and spacecraft structures. Will be required to solve special problems in elasticity, plasticity, short time creep and structural stability.

Design. Experience is required in preliminary and final structural engineering and design, including preliminary stress analysis. A knowledge of the effects of extreme temperature environment and hard vacuum, plus a background in materials is desired.

Heat Transfer

Space Vehicle Heat Transfer. Basic knowledge of radiation conduction and convection heat transfer with application to thermal control of space vehicles is required. Knowledge of spectrally-selective radiation coating, super-insulations and thermal vacuum testing is of particular value.

Aerothermodynamicist. Experience in hypersonic real gas dynamics, heat transfer, abalation; re-entry vehicle design, detection; shock layer, wake and rocket exhaust ionization; and anti-missile system requirements will be most useful.

Equipment Installation

Packaging and Installation Engineer. To perform optimum packaging and installation design for missile and/or spacecraft units, considering amount and geometric shape of space available as well as weight and center of gravity distribution requirements. Must be capable of analyzing structural adequacy of unit under extreme environmental conditions.

Controls

Optical Devices. Design, development, procurement and test operations are involved. Considerable experience in the field of optical devices for space applications such as star, horizon, sun and moon trackers.

System Test. To plan and supervise the operations of a flight control system laboratory. Air bearing tables and a wide variety of optical mechanical and electrical equipment are involved.

Control System Analysis. Requires engineers at various levels of experience including senior men capable of taking over-all project responsibility in the synthesis and analysis of control systems.

Circuit Design and Development. Experience in design and development of transistorized control system circuits, including various types of electronic switching and modulation techniques is required.

If you are a graduate mechanical engineer, electronic engineer, physicist or aeronautical engineer, with experience applicable to the above openings, please airmail your resume to: **Dr. F. P. Adler,** Manager, Space Systems Division, Hughes Aircraft Company, 11940 W. Jefferson Blvd., Culver City 51, California.

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IBM Gets Defense Com Center Award

The Defense Communications Agency has awarded a contract to IBM's Federal Systems Div. for design, fabrication, installation and maintenance of data processing, display and special communications terminal equipment for each of DOD's Area Communications Control Centers. Located in Europe, Alaska, Hawaii and Colorado, the systems consist of 6300 circuits in 73 countries. A solid-state 1410 Data processing system at each center will be able to supply information about the routes in its area, available alternate routes between two points and instructions for the most efficient utilization of the circuits.

Soviets Develop New Analog Computer

An analog computer—apparently the first of a new type of specialized simulators for the control of technological processes—has been reported by the Soviet Scientific Research Institute for Calculating Machines. Designated the MN-11, the computer can simulate non-linear differential equations up to the 6th-9th order and automatically find the solution to a problem using minimization and scanning methods. Circuitry consists of nine integrating circuits of up to nine inputs each, 38 adder circuits with varying inputs, six multiplier units, three controllable constant coefficient units and three variable coefficient units. Computer operates with a solution frequency of up to 100 cycles.

NASA Extends Cryogenic Gyro Pact

General Electric's Ordnance Dept. has received a $136,000 extension of its contract—awarded by NASA last June—for development work on cryogenic gyroscopes. The contract is part of the overall government-sponsored program to develop an advanced gyro based on the superconductive properties of materials at temperatures approaching absolute zero. The award will cover GE's MOD II gyro which has already been built and is undergoing preliminary tests preparatory to final run-up.

Pulsed Laser Operated by GE

A laser beam—pulsed rapidly and at high power—promises to take the laser out of the laboratory and put it to practical use in long-range optical radar. General Electric Engineering Laboratory scientists pulsed a new ruby laser at 10 bursts a second—with much higher power than the continuous beam laser. The main problem with the new development, GE said, is to increase the efficiency of the device in order to reduce the size and weight of the ancillary equipment.

SPACE MEDICINE

Soviets Establish Cosmic Biology Lab

A new Laboratory of Cosmic Biology has been established in the Institute of Cytology of the USSR Academy of Sciences. The only area of work reported was a project to study the behavior and adaptability of the cells of an organism to low temperatures—down to −180°—and to large doses of radiant energy.

ASW & SEABORNE ENGINEERING

Allied Navies Buy Hughes Radar

Four countries—France, Japan, The Netherlands and Italy—have bought a total of eight Hughes Frescan, three-dimensional radar systems from the U.S. Navy. Scheduled for installation aboard guided missile ships of these nations, Frescan is a frequency-scanning radar which can provide 3-D position information simultaneously on multiple supersonic airborne targets.

SUPPORT EQUIPMENT

Marines Evaluating Tac Air Control

A Tactical Air Operations Center of the advanced Marine Corps Tactical Data Systems is undergoing field tests at the Marine's Air Facility at Santa Ana, Calif. Built by the Data Systems Division of Litton Systems, Inc., TAOC is housed in eight helicopter-transportable huts. It permits the establishment of an integrated air defense, close air support, enroute traffic control and control of surface-to-air missiles during the initial phases of an amphibious assault.

ADVANCED MATERIALS

More on Maraging

Carpenter Steel is producing 18.5 and 20.0% Ni-steels under license from International Nickel Co. The steels are a high strength (250,000 psi) contender for missile/space applications such as motor cases. The steels, called NiMark I and II, require only a single aging treatment to attain the high yield strengths.

Liquid Neon in Production

Liquid neon is on a regular production schedule at the Linde Co., division of Union Carbide. Key to commercial availability is a shipping and storage container which holds neon loss to less than 0.3 liters per day. The low loss factor is accomplished by a combination of Linde's Super Insulation and liquid nitrogen shielding.

Space Radiation Fatality Odds Increased

Boeing scientists say solar flare radiation is not a major hazard in space flights lasting up to one week. The odds against a space crew getting a lethal dose in this time are 120 to 1. The study prompting the conclusion included solar flare predictions and spacecraft design.

High-Temperature Metals Lab Established

Sierra Metals Corp. is building a metal technology facility aimed at research into the development of new and improved high temperature alloys. R. H. Thielemann, former chairman of the Metallurgical Department at Stanford Research Institute, will head the new lab. The facility will be located near Portland, Ore.

Pogo-Hi Boosts Sea-Launch Stock

Navy hails adapted Army bird as forerunner of vast water-launch program, cites many advantages

by Bill Wilks

THE FIRST U.S. water-launched rocket will become operational this month on the Pacific Missile Range.

The *Pogo-Hi* rocket, adapted from an Army missile in the Navy's Project *Hydra* sea-launch research program, is only a small target-carrying vehicle. But it is seen as the first concrete evidence to back up the Navy's argument that eventually satellite boosters and manned spacecraft will be launched from the water.

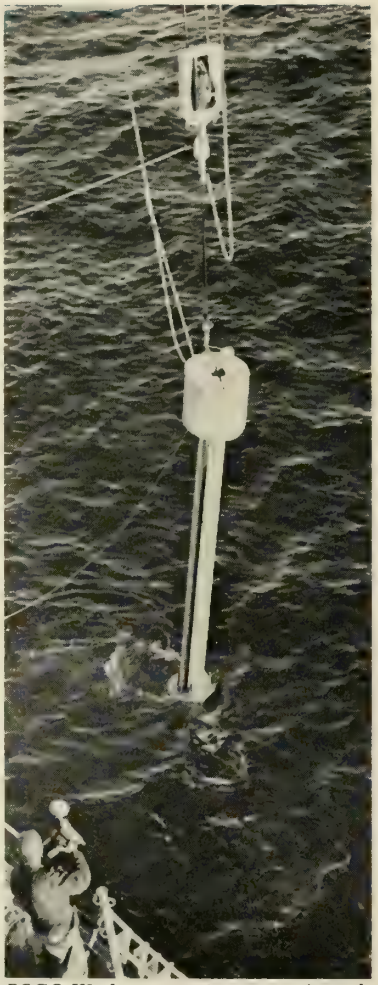
Over the next three months, the Naval Missile Center, Point Mugu, Calif., will use 24 *Pogo-Hi*'s for target practice in the *Terrier* and *Talos* development programs.

Approximately 8 ft. long, the Aeronca Manufacturing Corp. missile is powered by either a *Cajun* or *Apache* solid motor, both made by Thiokol Chemical Corp. Payload is a 24-ft. radar-reflective parachute which opens at 85,000-ft. peak altitude. As the vehicle descends, surface-to-air missiles equipped with miss-distance indicators use the parachute as a target.

The *Pogo-Hi* rocket is launched by radio command as it floats vertically in a simple, recoverable open-rail type launcher which holds the necessary launch circuitry. *Pogo-Hi* itself is not recoverable.

The Naval Missile Center obtained the *Pogo-Hi* Army rockets from the Naval Ordnance Test Station, China Lake, Calif., which got them from the Army's White Sands, N.M., facility.

To adapt the rocket to water launching, the Navy waterproofed it by slipping a 1½-ft.-long rubber boot over the nose area to protect the junctions and by plugging the nozzle with a plastic which blows out in the water on firing.



POGO-HI shown entering water after taking target aloft. Missile is not recoverable.

On launch, the rubber boot is stripped off by a wire attached to the launcher frame.

• **Only beginning** — Navy project officers see *Pogo-Hi* as a first step toward a much broader water-launch program.

Lt. Cmdr. John E. Draim, Astronautics Department, Naval Missile Center, told a recent regional meeting of the Institute of Navigation in La Jolla, Calif.: "By using solid-propellant motors already in the national stockpile, we can now design water-launched rockets for any kind of job."

While Draim did not discuss advanced military applications, the Navy believes use of such "off-the-shelf" missiles as *Minuteman* would be practical for water launchings. A recent NMC study concluded that *Minuteman* could be water-launched "with only minor modifications" and with a one-g benefit on launch resulting from buoyant forces characteristic of launch from a free-floating state. It also found that even in rather heavy seas, a properly adapted rocket leaves the water close to the vertical.

To the scientific community, Draim held out a "cheaper by the dozen" approach to meteorological and space investigation: "A relatively small vessel can carry a dozen different kinds of rockets and launch them in desirable remote areas without the expensive installations and safety problems associated with land facilities."

Major space probe work can be done with modified *Blue Scout Jr.* and *X-17* rockets transported and launched by destroyers and cargo vessels, he said, permitting almost unlimited mobility, improved rocket performance for many

missions and substantial economies in time and money.

As for immediate Navy application of the water-launch technique, Draim said *Pogo-Hi* frees vessels from dependence upon aircraft and shore installations for target launching—"Now a ship can carry and launch its own targets for missile practice on the open sea. It can stick *Pogos* in the water, then move, say 10 miles away, and launch them simultaneously."

In event the Navy decides to make wider use of *Pogo-Hi* than is planned in the immediate future at NMC, Draim reported, "We probably can make all of our own with very little funding."

NMC adapted *Pogo-Hi* in a strictly in-house program at very modest cost, Draim said, estimating roughly $3000 to $5000 for each of the 24 now ready for use, and $500 worth of materials per launcher. For the waterproof electronics container attached to the bottom of the launcher NMC, working mostly with local funds, adapted a standard steel shipping container obtained from stock.

• **Sixty shots** — Draim said feasibility of the basic water-launch method has been confirmed in 60 PMR launches of rocket simulators and actual rockets. Shapes ranging in length from 3 ft. to 105 ft. and in weight from 20 lbs. to more than 10 tons have been launched. Liquid rockets also have been fired with only the water as a launch pad. Aerojet-General Corp. last fall twice launched the same *Seabee* rocket, a slightly modified version of the liquid-propelled *Aerobee-100*.

"Since land-launched rockets can be *Hydra*-launched, performance need not be degraded by requiring off-optimum designs," Draim said. "On the contrary, it has been shown that usually a small but significant increase in performance is contributed to a given rocket by the water-launch method."

Both the Navy and Aerojet have been trying to interest NASA in the technique, apparently without success so far.

• **Repertory** — Draim listed these possible uses of water-launched vehicles:

—Meteorological probes dropped overboard from ships.

—Scientific payloads.

—Emergency communications.

—Target applications.

• **Pluses** — He reported these advantages:

—Mobility is virtually unlimited, since 70% of the earth's surface is a potential launch pad.

—Range safety problems are eased. Many launching problems at existing land sites are due to congestion, limitations on firing bearings. Probes launched at sea do not have to be fired at depressed angles to avoid populated areas.

—Elimination of launch pads, towers, blockhouses and range safety requirements yields great economies in both time and money.

—Launch pad safety is obtained by stationing the ship outside the launch area.

—Almost any ship can carry and launch small, medium and large rockets.

—Extensive support facilities at remote locations need not be constructed.

—Simultaneous countdowns and firings can be accomplished, since there is no limitation on the number of rockets than can be launched from the "pad" at one time.

The *Hydra II* vehicle used in the water launch test program is a 10-ton, 40 ft. boiler-plate rocket simulator constructed by Long Beach (Calif.) Naval Shipyard especially for Project *Hydra*. It is powered by an "overage" and therefore surplus Aerojet *Genie* solid booster.

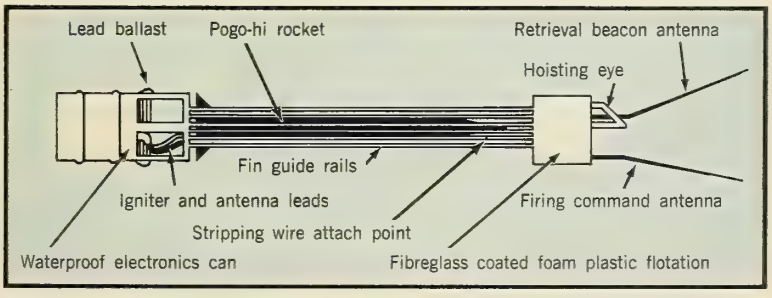
Carrying instrumentation in the nose, the recoverable *Hydra II* has been launched a number of times with a very short burntime, going as high as 140 ft. It is considered significant that it has never been damaged in open-sea launchings of state 3 condition—the average for open-sea operations. *Hydra II* is scheduled for further launchings.

Hydra II followed *Hydra I*, which was a wooden dummy about 5 ft. in length, turned out on a lathe and powered by a 2.25-in. *Aeroscar* solid rocket.

Hydra numbers have been assigned to only two vehicles to date, although some 60 have been used in the water-launch program.

"We decided to number some of the significant test vehicles which were designed as such," Draim explained. "For the others, the telephone pole and the sewer pipe, we didn't bother to dignify them with a number."

The pole was 105 ft. in length, about six tons in weight. The sewer pipe was just that, about 40 ft. long, 3 tons in weight, and powered by a Thiokol Chemical Corp. liquid *Sparrow* motor. ⌗

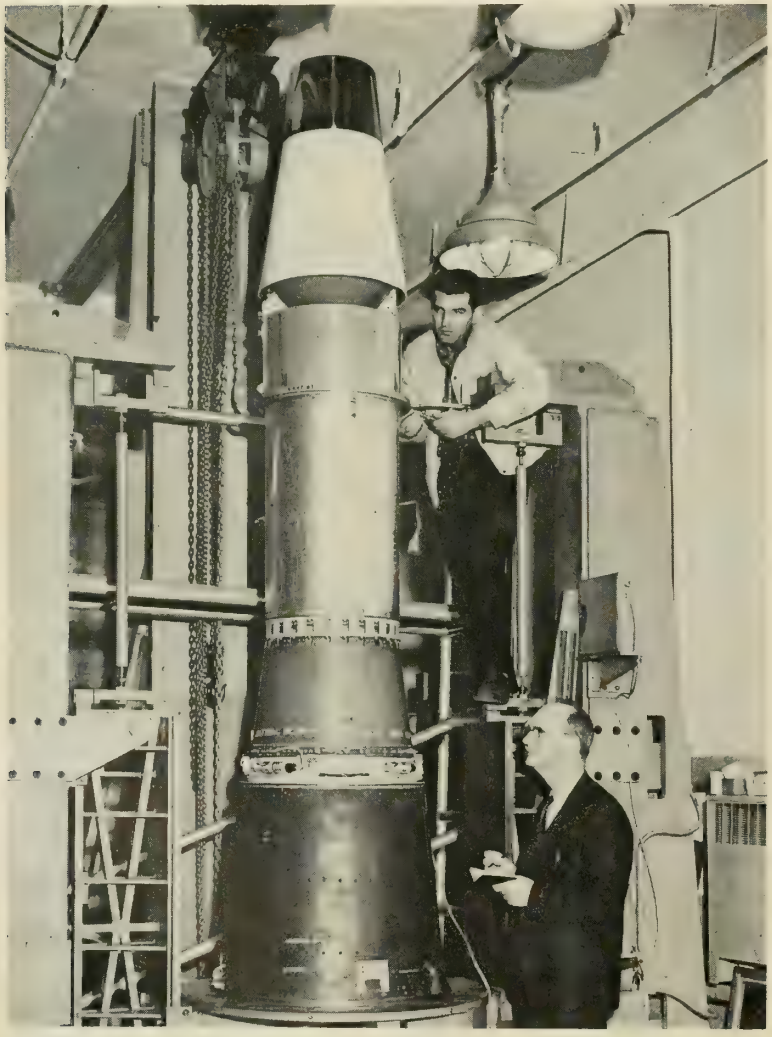


ABOVE: *Drawing shows Pogo-Hi rocket on its launcher. Navy estimates that Pogos were adapted for only $3000-$5000 apiece, and launcher materials cost $500 each.*

BELOW: *Built by Navy expressly for launch test project, Hydra II vehicle weighs 10 tons, is 40 ft. long, have never been damaged in series of open-sea firings.*

New Stages Hiking Scout Payload Over 1/3

X-259 third stage and Aerojet's Algol 11A first stage to lift total impulse almost 25%; new fourth stage in trouble



SCOUT 8, shown here on spin balance table at Wallops Island, Va., is given a fifth stage to accelerate payload to about 19,000 mph in atmospheric re-entry test.

TWO NEW SOLID-MOTOR stages will boost the *Scout* launch vehicle's payload capability from 150 to over 200 lbs.

The stages are the *X-259* third stage and the *Algol-11A* first stage.

The third stage has already been static-fired successfully and a flight test is scheduled this spring. The new first stage will be static-fired in a couple of months and will be flight-tested late this summer.

Meanwhile, MISSILES AND ROCKETS also learned that a new fourth stage for *Scout*—designated the *X-258*—has run into serious difficulty. Informed sources report that NASA is giving serious consideration to dropping it, but no final decision has been made.

The increased performance in the new first stage stems from a new propellant and grain design. The producer, Aerojet-General, estimates that *Algol-11A* will have 25% higher performance than its predecessor, *Algol 1*.

The new version will use the same chamber as *Algol 1*, but a plastic nozzle will replace the steel type formerly used.

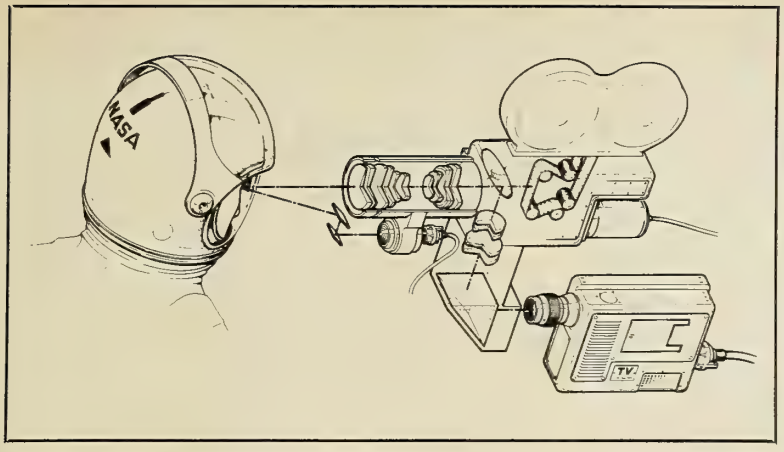
Total impulse of the improved version is nearly 5,000,000 lb. sec., compared with 4,000,000 for *Algol 1*, and the mass fraction has been increased from 0.84 to 0.90%. The engine, known as the *Aerojet Senior* in its earlier applications, has a perfect record of reliability in 12 flight tests and numerous static tests.

The improved performance will enable *Scout* vehicles to carry either a heavier payload to present ranges, or present payloads to greater ranges. Because of the reliability record of the earlier version, Aerojet-General is planning only a limited test program for the engine. First tests are expected to begin in the immediate future, with deliveries following quickly.

The *Aerojet Senior*, originally developed in 1957 to prove the feasibility of the large solid rocket, was chosen for NASA's *Scout* and the Air Force's *Blue Scout* as an off-the-shelf item.

• **Twin advances**—Aerojet said a denser, higher-energy propellant was the key to the improved engine, but declined to elaborate on either the propellant composition or grain design, presumably because of a tie-in with a military vehicle. The 25% figure for improved performance reflects a combined advantage: increased thrust level and longer burning time, with the latter the more significant.

The Air Force probably will buy some of the improved engines from NASA for use with *Blue Scout*, but plans for this are not yet firm. The thrust level of *Algol 1* is about 110,000 lbs., and a slight increase is expected in the new version. ⁂



OPTHALMOSCOPE monitors astronauts' condition through eyes.

space medicine

Device Will Keep Watch On Astronaut's Telltale Eyes

by Heather M. David

WITHIN A FEW months, NASA will have a tool to anticipate ill effects of spaceflight by looking into astronauts' eyes.

The tool is an opthalmoscope, an instrument which monitors and records the flow of blood and precise condition of the eye. With this device, doctors can detect minute changes in the astronaut's whole physiological condition. These small changes may be danger signals of impending nausea, high blood pressure or injury or illness of the brain.

Pacific Optical Corp., a division of Chicago Aerial Industries, will deliver the apparatus to the NASA Ames Laboratory for use in a centrifuge cabin. It is anticipated that if the devices perform well, it may be incorporated into the *Mercury* program.

When the system is used on the centrifuge, it will be hooked up to a television camera which will transmit eye movements to a remote control tracking device. Simultaneously a color film recording will be made.

An especially interesting feature of the system is a lens that will record retina details and eye changes as small as ten microns, about 5/10,000 of an inch.

The principle of the system is that a ray of light is beamed into the far reaches of the eye and reflected from the retina. Doctors can then observe minute changes in the arteries of the eye. These arteries may show changes such as hardening, or indicate hypertension and diabetes. Swellings of the optical nerves may show otherwise undetectable tumors or other causes of brain pressure. Cellular changes may also be reflected.

Pacific Optical spokesmen said that the instrument could be adapted for flight use, using a 35 mm movie or still camera, or even a 16 mm or 8 mm camera. The basic instrument itself weighs only about 15 lbs. ⌗

Packaged Plastic Records Radiation Dosage in X-15

A RADIATION DETECTION package containing plastic simulating the radiation-absorption qualities of human tissue has shown that *X-15* pilots have been exposed to negligible amounts of cosmic radiation.

The package, which weighs 12 lbs. and is attached to the *X-15* cockpit wall at the left of the pilot, marks the first Air Force attempt to measure radiation in the cockpit. Plastic components in the device have essentially the same radiation-stopping ability as human tissue. By using different thicknesses of plastic for different flights, it is possible to determine the radiation dose rate at different depths in tissue.

The device was developed jointly by Air Force Flight Test Center (Edwards AFB), the Air Force Special Weapons Center, Kirtland AFB, N.M., and NASA. Similar packages are now being flown aboard ballistic missiles, *Discoverer* satellites and other Air Force high-altitude flights. ⌗

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Circle No. 9 on Subscriber Service Card

DOD Use Seen for Ion Bounce System

by Michael Getler

NEW YORK—A new ionospheric communication system, originally conceived to transmit high-frequency FM radio and television over long distances and times, may turn out to have considerably wider military import.

The system, dubbed "Far Horizon" by its developers—the Sperry Gyroscope Co. of Great Neck, L.I., N.Y., a division of Sperry Rand Corp.—employs two frequency-controlled high-intensity microwave beams transmitted from earth to sustain ionization of a rocket-deposited cesium cloud in the ionosphere for periods up to eight hours.

Though still in the concept stage, the company-funded program is reported to have attracted the attention of at least two military research agencies.

An operational system of this type could, Sperry officials say, provide the military with a rapidly activated long-range communications and intelligence network with complete control over the timing, location, and duration of the reflective cloud. At the same time, the military would be able to deny use of the system to the enemy through control of the sustaining microwave energy.

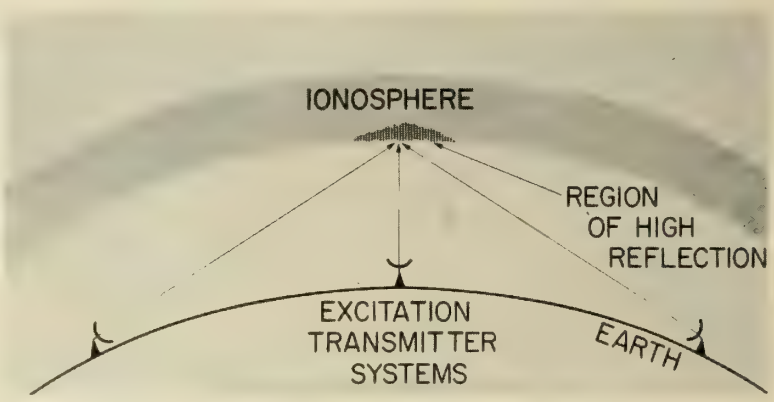
This type of operation, engineers contend, provides more complete military security than systems involving placement of permanent reflective matter in space.

In addition to an active communication role, Sperry officials working on the project speculate that "Far Horizon" could fulfill some highly significant intelligence missions:

• **Missile tracking**—With good on-hand intelligence concerning probable timing for missile or space activity by any potential aggressor, the ionosphere's reflectivity could be enhanced at will to allow very long-range radar observation and tracking of actual missile or space vehicle launchings.

• **Radio monitoring**—Such a system could also be useful for monitoring the usually increased levels of radio activity which precede missile launchings, and for additional monitoring of normally secure beyond-line-of-sight communications.

• **Forward observation** — Some radar observation of heavy ground activity could be accomplished at long ranges, but resolution for this type of effort would be extremely low.



Excited Ionosphere Transmission System

Basically, what "Far Horizon" would do is expand the maximum useable frequency for long-range ionospheric communications from roughly 3.5 mc to between 100 and 200 mc, thereby opening up a considerable broadcast band for high-frequency communication of all types, including live international television.

The concept of bouncing high-frequency signals off chemically-seeded clouds is not new. The U.S. Army Signal Corps successfully bounced a 100 mc TV signal between Texas and Florida using this technique. However, the duration of the reflective material has previously been limited to about one-half hour, the time it takes for dispersion by normal electron loss within the ionized gas.

According to the Sperry concept, this electron loss can be slowed and ionization "kept alive" for periods up to eight hours through injection into the ionosphere of properly heterodyned microwave frequencies.

To accomplish this, engineers would take advantage of the nonlinear characteristic of the ionized gas. Since a nonlinear medium will generate the sum, difference, and harmonics of any two or more RF signals present, Sperry proposes to inject two frequencies that will be absorbed by the ionosphere and that are separated by 1.3 mc.

This 1.3 mc differential represents the cyclotron frequency of the ionosphere, and is that frequency which is most apt to enhance the level of free electrons within the ionized gas.

Since this 1.3 mc frequency is normally reflected by the ionosphere when transmitted directly from earth, Sperry proposes to make use of the nonlinear nature of the ionized gas by transmitting two RF frequencies which will be absorbed by the ionosphere and which will then produce the desired 1.3 mc within the ionospheric volume.

• **Low power needs**—This dual-beam concept is also expected to allow the use of smaller transmitting antennas at relatively low power levels to maintain the highly directional energy required to sustain ionization. Scientists also indicated that the two beams could be transmitted from a single antenna.

Actual power requirements to support this heterodyned pumping technique have been described by engineers on the project as smaller by an order of magnitude than power levels needed to initiate ionization by the voltage breakdown method.

Sperry has based the "Far Horizon" principle on the natural makeup of the ionosphere, the outer portion of the atmosphere made up of ionized molecules which surround the earth in layers from 40 to 250 miles up.

These layers, ordinarily excited by absorption of the sun's energy or the passage of meteorites, can presently reflect radio energy up to 3 or 4 mc with no artificial stimulation. At higher frequencies, energy begins to filter through the ionosphere at an increasing rate and is lost for useful communications.

Higher levels of artificially sustained ionization, such as proposed in "Far Horizon" could present a virtually solid reflective wall into even the ultra-high frequency range, thereby greatly increasing channel availability for long-range communications. ⁂

He solved this puzzle by taking it apart!

Like oil and water, extreme precision and "complete" mobility resist combination in tracking radar antennas. Designing for one of these characteristics "automatically" precludes the other. *That* was this AMF Engineer's puzzle—to put *both* precision *and* mobility in an antenna for duty with the Marine Corps.

He solved the puzzle, literally, by taking apart the solution—AMF's TPQ-10 antenna—into 10 rugged, portable, submersible, precision-fabricated packages. TPQ-10 is designed for helicopter transport. Each component can be dropped in water; it will come up for more. The packaged antenna on its pallet can be dropped on land from 3 feet without impairing precision.

Each component can be *picked* up—the largest weighs 425 lbs.—and can be handled by 3 men. A crew of 6 can put TPQ-10 together in 20 minutes with one standard wrench.

Among the design innovations that solved the puzzle is a "piggyback" gear arrangement that puts both azimuth and elevation drives in one package. Result: almost half the parts and weight of separate components. Precision fabrication is typified by the reflector arms, held to a .005" deviation over 45 inches!

(For unclassified information on early warning and radar antenna systems, write Dept. CS 1, address below.)

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Polaris Launcher Production Hits

Westinghouse division doubles space, expands work force by one-third to meet program speed-up

SUNNYVALE, CALIF. — *Polaris* missile tube launchers are now coming off the production line at an accelerated rate of four a week.

Westinghouse Electric Corp.'s Sunnyvale Division, prime for the launching system, stepped up the pace in December to meet the 18-month leadtime for launchers going into Lafayette-class *Polaris* submarines. The Navy has scheduled this class of sub for a one-a-month commissioning in late 1963.

To gear up for the accelerated production demands, Westinghouse doubled its launch system production space to almost 200,000 sq. ft. and increased its work force by one-third, to 1500 persons.

Although engineering of refinements to the launch system is continuing, Westinghouse says the basic launcher has now evolved and is being produced on an assembly-line basis with few problems. Modifications to the launching-handling systems required by the 2500-mile-range *Polaris A-3* were fed into the production program some time ago.

Each of the 16 tubes for each submarine is built as a separate unit, then integrated into a central control system. These are the major elements of the launcher:

—The launch tube.

—A hydraulically controlled pneumatic valve.

—An umbilical retraction system.

—A diaphragm enclosing the top of each tube.

—An air flask for each tube.

—A control system which monitors the subsystems of each launcher and controls interlocks on the entire system.

• **New dimensions**—Launch tubes for the six George Washington-class *Polaris* submarines are 28½ ft. For the *A-2* and *A-3 Polaris* vehicles, the tubes were extended 30 in. to 31 ft.

Diameter of the tube is 57 in., three inches wider than the missile. Three 1½-in. shoes around the vehicle retain it in place, keep the chamber pressure at ejection and break loose after launching.

The tubes are made in five sections, 5 to 7 ft. long. Each segment is bored separately and assembled at the end of the production cycle. Segmentation is necessary because of a 7-ft. boring machinery maximum.

Pre-cut, rolled-steel sections are acquired from commercial processors and milled from about ¾ in. to ⅜ in. Three access ports are cut into the tubes:

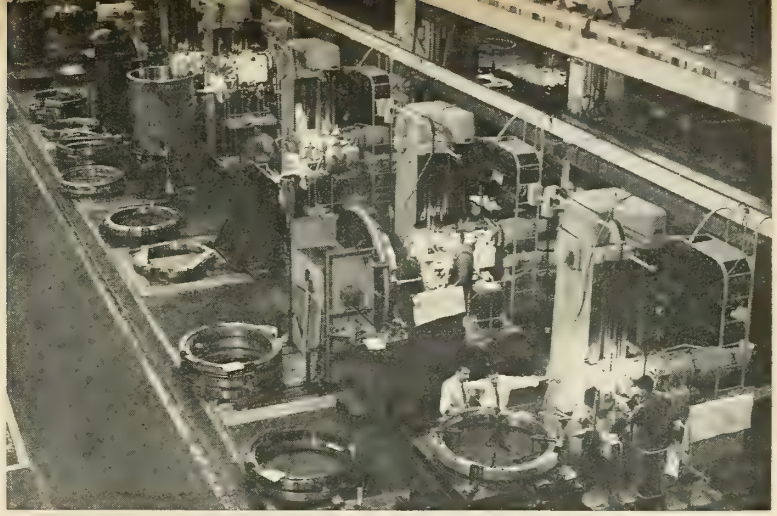
—One at the forward end for reentry vehicle inspection and access to the missile's guidance system.

—Two in the mid-section for inspection of the vehicle's interstage.

DIAMETER OF ACCESS DOOR is measured by engineer George Grant. Ports are for inspection of vehicle interstage.

FINAL ASSEMBLY AREA at Westinghouse launch tube production facility. Hydrotest area is at right rear of photo.

Four a Week



LARGE machine tools used in fabricating launch tube components. At right are base and muzzle lid rings.

Each port is covered by a steel door backed with lightweight plastic to ease opening and closing during on-board inspection. Also cut into the tube is a hole for mounting of the umbilical retract system.

• **Elaborate precautions**—Assembly of the tubes is achieved by bolted flanges at each joint. Each tube is hydrotested to a level considerably higher than pressures expected at lowest depths at which the submarine will launch. The tubes must be watertight because sea water floods them after launching.

An elaborate shock absorption system is used to minimize jarring and overloads during depth charge attacks.

Each tube is mounted on 20-30 vertical and lateral clevis pads connected to an outer tube in the submarine by liquid (silicone) springs. This gives the tube a small degree of floating action.

The missiles are held tight in their tubes by a pendulous-mounted hold-down right at the aft end of the vehicle. Beryllium copper spring rods projecting from the tube support the missile in this pendulum-fashion mounting. Avoiding rigid anchoring of the missile eliminates the hazard of high bending moments on the missile, and lateral shocks are absorbed. Before launching the ring can be loosened quickly.

In operation, the outside hatches of the sub's missile tubes are opened first. The diaphragms keep sea water from pouring into the tubes. On launch, a jolt of compressed air is released from the storage flask—propelling the missile upward through the diaphragm, through the water and above the surface where the first stage is ignited by computer command.

Shaped like a large picnic jug, the valve is connected to the tube by an 8-10-in. pipe. It is fed by a banana-shaped canister containing a charge of compressed air. Westinghouse subcontracts production of the air flasks to the National Tube Division of U.S. Steel and Babcock & Wilcox Corp.

Each of the 16 launchers is controlled and monitored from the central switchboard. Each air bottle is kept constantly charged for quick response and air pressures are registered for each tube. Back-ups are integrated into the system in case of failure in the primary network.

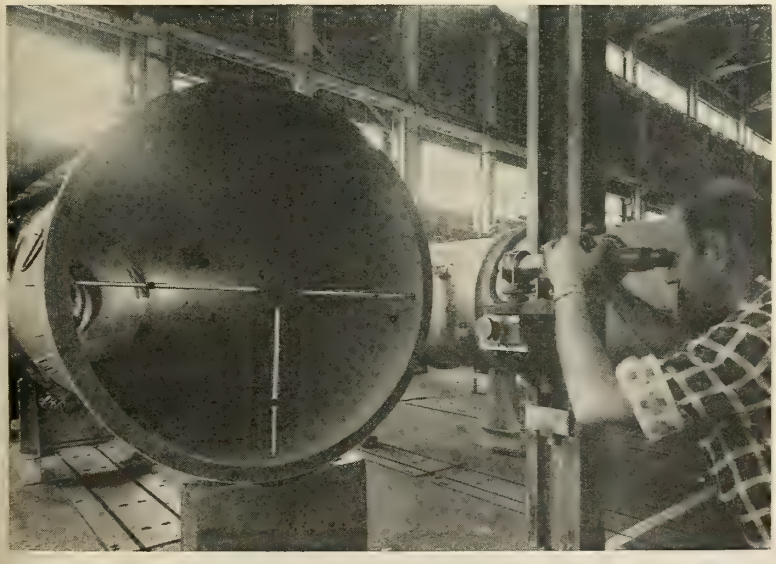
A complex of interlocks make it impossible to begin launch operations unless all channels are clear. Besides interlocks within the missile itself, there are interlocks requiring the tube hatch to be open before launchings, the air pressure to be adequate, the hold-down ring to be released and the access doors to be closed. The umbilical is withdrawn as the missile is launched.

• **Geared up**—To meet the production speed-up triggered by the *Polaris* acceleration last summer, Westinghouse has added 25 new light machine tools, five of them automatic-tape-controlled. Additionally, the Navy has provided 17 vertical and horizontal boring mills and drill presses.

Lockheed Missiles & Space Co., prime contractor for the *Polaris* system, is located less than three miles from the Westinghouse plant, which was converted for the *Polaris* production from a heavy machine tool plant.

More than 9000 subcontractors work on the launcher system. Much of the electronic control-monitoring production is subcontracted.

Westinghouse ships the finished launchers from here by train and barge to the shipyards now involved in the *Polaris* submarine-building program—Mare Island, Newport News and Portsmouth Naval Yards and the Electric Boat Co. at Groton, Conn. ⌗



LAUNCHER TUBE ALIGNMENT is checked by assembler Ray Fry. Target cross hairs indicate close tolerences.

Modular Approach for Apollo G&C

Earth-orbit package is base for system; NASA will choose industry contractor shortly

NASA INTENDS to use a "building-block" approach to developing the *Apollo* guidance system.

The basic system will be developed —and standardized—around the guidance package used in the earth-orbiting mission. To this will be added the components or modules needed for the circumlunar and lunar-landing phases of the program.

For training purposes, however, the circumlunar guidance package will be adopted as the basic system, in order to familiarize astronauts with the navigation requirements and procedures for the lunar mission.

In describing the development of the *Apollo* guidance system, Cmdr. Albert J. Kelley, Director of Electronics and Control in NASA's Office of Advanced Research and Technology, told M/R that one or more industrial support contractors would be chosen shortly to work with MIT on the system.

Citing the similar approach used by the Navy on *Polaris*, Kelley (who holds a PhD from MIT) said that the industrial support contractors would work right along side the MIT development team.

However, he stressed that these industrial contractors would not necessarily be assured of winning the production contract for the guidance packages. The mechanics of the award have not yet been firmly established, but the pact will presumably be let on the basis of competitive bids.

MIT was selected as the associate prime contractor for the *Apollo* guidance system last year—even before the award of the Command and Service modules contract to North American.

Although the present pact with MIT is only for delivery of the earth-orbiting packages, the instrumentation laboratory will also develop the guidance systems for the circumlunar and lunar-landing missions. In fact, they are already examining techniques and components to achieve these more complex goals with minimum change to the primary—earth-orbiting—system.

At present these and other questions are under intensive study within NASA. However, the agency expects to begin in the near future an aggressive program of electronics and control research expected to feed ideas and techniques into not only the rendezvous and *Apollo* programs but all other NASA programs as well.

The idea, according to Cmdr. Kelley, will be to have several companies study various aspects of problems in the guidance and electronic areas of *Apollo*. Some overlapping of programs will be allowed, but generally each study task will define a specific problem and recommend solutions. The overall purpose of the program will be to advance the electronic state of the art so that when the *Apollo* program or any other project needs a particular component or technique, it will already be available.

• **Office created recently** — Established in the complete organizational shakeup of NASA in November, Cmdr. Kelley's office is responsible for the management of the Space Agency's advanced R&D efforts in electronics, guidance and control. It also acts in a technical advisory capacity for NASA programs.

Since the recent retirement of Ira H. Abbott as director of the Office of Advanced Research and Technology, Cmdr. Kelley has been reporting to the Acting Director, Deputy Associate Administrator Thomas F. Dixon. Within the office of Electronics and Control, the responsibilities are distributed

How Echo Disintegrated in Space

EXPLOSION of "rigid" Echo communications satellite sphere Jan. 15 is shown in this series of photos. The sphere tore apart in space moments after it was released from its Thor booster. Camera (a Milliken DBM 10) was mounted in a capsule which was later recovered from the Atlantic. There was speculation an object whizzing through space could have punctured the balloon as it was inflating.

among four deputies—some of whom have yet to be named—one heading each of the following offices: Guidance and Navigation, Control and Stabilization, Communications and Tracking and Instrumentation and Data Processing.

• **Rendezvous problems outlined**—Turning to the much-discussed orbital rendezvous, Cmdr. Kelley asserted that the problems have probably been overemphasized. He quickly added, however, that we cannot be sure until "we get up there and start banging some together." The problem, he feels, is analogous to the aerial refueling of airplanes—without the difficulties caused by the turbulence of the atmosphere.

Implicit throughout his discussion, however, is the importance of man to orbital operations. The versatility, flexibility and adaptability of a man would be hard to match with an automatic rendezvous approach. Therefore, the link-up in the early phases will most likely be semiautomatic. Still, since it is impractical to send an astronaut into space everytime a rendezvous mission is contemplated, an automatic system will eventually have to be developed.

Early manned rendezvous flights using the Mark II capsule will carry state-of-the-art equipment because of the tight development and launch schedules imposed on the program. The target vehicle will be launched and its orbit determined with presently available tracking and data-processing stations. The manned vehicle, after launch, will be ground-guided into a suitable orbit. From there the rendezvous will be effected.

One method of accomplishing this is to initially pick up the target vehicle by homing on a transponder or reflector on the passive orbiter with a radar mounted in the chaser. An on-board computer then determines the corrections necessary for a close rendezvous.

For terminal homing or closing, the pilot—using a periscope, TV, IR or radar with a time delay, or any combination—would guide the chaser to the final linkup. A display—similar to that used in all-weather fighter aircraft—would allow the pilot to adjust his range rate marker to his closing rate. As he got closer to the target vehicle, the display pattern would collapse toward the center of the scope until the final linkup was effected.

• **Research problems defined**—The overriding problem in NASA's electronic research program is to provide advanced techniques in a reliable flight condition for the agency's programs.

To do this, the office is interested in programs covering the entire spectrum of electronics research, particularly in these areas:

—Improving the accuracy and reliability of analog-digital-analog-conversion systems. Of interest in this area are accurate (seconds of arc) direct digital pickoffs and direct digital transducers to eliminate some of the conversion problems.

—Reliable speech communications systems for manned spacecraft. Noting that coding or statistical treatment of speech may be possible, Kelley stressed the importance of developing interference-free communications.

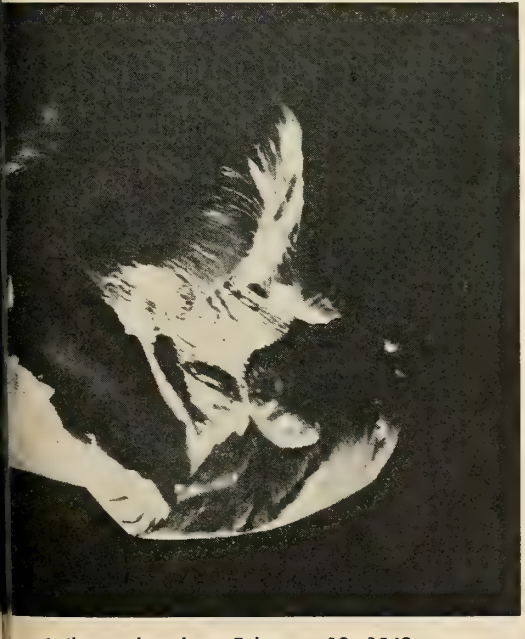
—Reliable re-entry communications. Areas being investigated by NASA to solve this problem of blackout during re-entry include: material addition to neutralize the plasma sheath; artificial magnetic fields around the vehicle; continued investigation of transmission frequencies; and changes in vehicle configuration to change the flow of the plasma sheath.

—Feasibility and performance of multiple, slaved antennas as contrasted to a single large dish. Since the frequency characteristics and reliability are better for multiple smaller dishes, a number of these antennas may well give better overall performance than a single large dish. Alignment of multiple dishes is considered a problem. The performance of fixed arrays is also of interest.

—Investigation of the broad spectrum of instrumentation so that when an experimenter needs a specific technique it will be available. The field of biomedical instrumentation—because of the inadequacy of present techniques—is of vital interest.

—Improvement of data-processing systems, particularly selective monitoring of telemetry signals so that only selected data are broadcast to the ground.

In the area of manned flight, Cmdr. Kelley praised the important work being done at Ames Research Center on man-machine integration and at Edwards AFB on the *X-15* energy management studies. Both of these efforts will contribute significantly to insuring that the crew of a spacecraft is not saddled with an excessive in-flight workload — or, conversely, deprived of tasks which they could readily perform. ⌗



Douglas, Newport News Team To Bid on Big Solid Cases

DOUGLAS AIRCRAFT Co. and Newport News Shipbuilding and Dry Dock Co. have formed a team to bid on production of giant solid-propellant motor cases.

Douglas said the combination of two such diversified companies was needed because sizes of the large motors being considered would "far exceed the sizes of any similar hardware now being produced by the Aerospace Industry."

R. L. Johnson, VP and Director of Product Development for the Missile and Space Systems Division, said DAC's motor case experience—including *Nike-Zeus* and *Skybolt* — coupled with the shipbuilder's capability in fabrication of large structures, "will assure the success of the large motor case program by minimizing size problems while calling on existing know-how. With this team, we feel have a unique combination of technical experience and manufacturing capability".

Fabrication would be done at Newport News, Va., where "all of the forming, machining and handling facilities required to start building the huge cases are on hand at the shipyard and could be made available if required," Douglas said.

Other advantages Douglas sees in the deal:

—Location of the shipyard on the East Coast would facilitate transportation of hardware to the loading site.

—The integrated facility would avoid the problems involved in "forming components in one location, machining them in another and assembling them at still a third."

Although diameters to 300 in. and lengths to 200 ft. are being considered, few major technological breakthroughs should be required, Johnson said. Because of the large sizes, sections of the motor cases would have to be individually formed and machined and then welded together, he added. "Basically, our task will be to scale up proven technologies, extend present capability and utilize available production capacity."

Douglas, which feels the "roll-and-weld" method is the "only feasible approach" to fabrication of motor cases more than 10 ft. in diameter, said it would design the cases and establish the necessary process specifications. Tool design would be a joint effort, with tool fabrication, hardware manufacture and process control performed by Newport News.

Newport News, which covers 250 acres, would build a large motor case production facility. But, to permit earliest possible delivery of development hardware, the shipyard could use its present equipment while the new facility was being constructed.

Newport News built the world's largest ship, the nuclear-powered aircraft carrier Enterprise. ⌗

BENDIX CORP. formed two subsidiary companies in Baltimore to handle operation and maintenance of missile and space stations, defense equipment, command and control communications, and electronic facilities for U.S. and other governments on a contractual basis.

The Bendix Field Engineering Corp. and Bendix Commercial Service Corp. evolved from a field engineering department of Bendix Radio Div. President of both companies is Leister F. Graffis, former manager of the field engineering department.

PM ELECTRONICS, INC. acquired California Instruments Corp. CIC, developer of an new 10-meg solid-state automatic oscilloscope, was formed last July. PM will concentrate on amplifiers and oscilloscope lines, and will develop additional products.

DYNATRONICS, INC. is building a 31,000-sq.-ft. addition to its Orlando, Fla., plant. The new wing, scheduled for completion in April, will be used primarily to expand the company's manufacturing and data-system R&D operations.

NORTH AMERICAN AVIATION, INC. says it plans to build an $815,000 advanced liquid-propellant research facility north of Reno, Nev. It would be used by the company's Rocketdyne Div. to develop propellants and engines primarily for outer space use.

The facility would be approximately one mile north of NAA's nearly completed advanced solid-propellant research facility. Construction is scheduled to begin April, with occupancy in October.

LAVOIE LABORATORIES, INC., Morganville, N.J. is building a new Test Dept. facility. The company produces and develops electronic systems, instruments and automatic test equipment for military and industrial applications.

DEFENSE ELECTRONICS, INC. Rockville, Md., has established an engineering office in Winter Park, Fla. to provide engineering liaison assistance to the AMR at Cape Canaveral, Marshall Space Flight Center and other users of DEI telemetry, tracking, data processing and other equipment.

IBM'S Federal Systems Div. established an additional engineering laboratory at Fort Lauderdale, Fla., to develop advanced military control and space support systems. Occupancy is scheduled in April, with 500 engineering personnel to be added in the following 15 months.

The group will translate government requirements for total mobile and ground-based information-handling and control systems into electronic equipment in such areas as space support, space surveillance, undersea warfare, command and control, and intelligence.

CENTECH CORP. has been formed in Des Plaines, Ill., as an R&D firm in the fields of electromechanics, electronics, instrumentation, metals, materials and operations. President is Dr. Robert Petersen, former president of Booz-Allen Applied Research Inc.

TRW ELECTRONICS INC. was established as a subsidiary of Thompson Ramo Wooldridge Inc. to provide management, marketing, administrative and technical services for a number of electronic organizations within the parent company. Products marketed by TRW Electronics, with an established $50 million in sales, include precision electronic components and assemblies for use in industrial and consumer goods as well as in military equipment.

CUBIC CORP. has formed a British subsidiary, Cubic Electronics Ltd., with offices in London. Negotiations are under way with several English firms to promote and manufacture modified versions of Cubic aerospace tracking systems for sale both in Great Britain and throughout the Commonwealth.

WYLE LABORATORIES has acquired Liberty Electronics Corp. and two affiliated companies, Flight Electronics Supply Corp. and Atlas Electronics, Inc. Liberty and Flight are in Inglewood, and Atlas in San Diego.

ATLANTIC RESEARCH CORP. acquired General Communication Co. of Boston. GC designs and manufactures IFF gear, coaxial switches, radar beacons, and pulse-power calibrators.

Among Top EDTR primes . . .

Many New Names on Contractor List

A QUICK PERUSAL of the list of 500 military prime Experimental, Development, Test and Research (EDTR) contractors for Fiscal 1961 shows that of the total approximately 25% did not appear on the Fiscal '60 list. Also, although total awards of $10,000 or more for EDTR increased from $5,532 million in '60 to $6,025 in '61 the top five firms account for 39.2% of the total this year, as compared with 42.2% last year.

Lockheed and General Dynamics traded places for the No. 1 spot, while North American and General Electric retained third and fourth respectively and Martin replaced Western Electric in the fifth position.

Several others jumped far above their last year's standings to find a firm berth in the top 100 for Fiscal '61. Among them: Yardney Electric Corp.—from 393 to 62; Geotechnical Corp.—from 162 to 60; Solar Aircraft Co.—from 255 to 74; and National Cash Register Co.—from 171 to 95. Some, of course, went the other way. For example: Raytheon Co.—from 19 to 24; Burroughs Corp.—from 32 to 48; Litton Systems, Inc.—from 39 to 61; and Chrysler Corp.—from 62 to 93.

Dollar-wise, many firms received almost the same amount of awards in both years; Sylvania Electric Products, Inc., McDonnell Aircraft Corp., Motorola Inc., Curtiss-Wright Corp., and Callery Chemical Co., to name a few.

Contractors on this top 500 list accounted for 98.8% of the total awards in '61; 98.4% in '60 and 99.3% in Fiscal '59. In '61 as in '60, 88% of the EDTR awards went to U.S. firms for work with guided missiles, aircraft, ships and electronics.

Of the total 1782 contractors, 416 were government, non-profit or foreign organizations, 570 large U.S. firms and 796—58.3% small firms.

FY '61 Rank		COMPANY	FY '61 Contracts (in thousands)	FY '60 Contracts (in thousands)
1	(2)*	General Dynamics Corp.	577,034	528,057
2	(1)	Lockheed Aircraft Corp.	576,341	666,306
3	(3)	North American Aviation, Inc.	505,405	473,797
4	(4)	General Electric Co.	384,625	396,722
5	(6)	Martin Co.	319,743	245,799
6	(7)	Boeing Co.	291,831	205,734
7	(5)	Western Electric Co.	279,236	270,306
8	(8)	Aerojet-General Corp.	193,214	182,464
9	(12)	Thiokol Chemical Corp.	151,296	99,355
10	(10)	Westinghouse Electric Corp.	149,441	118,448
11	(9)	Sperry Rand Corp.	145,319	120,077
12	(11)	Douglas Aircraft Co.	132,978	100,264
13	(16)	United Aircraft Corp.	105,434	78,345
14	(35)	Pan American Wld. Awys., Inc.	98,100	17,626
15	(18)	IT&T	96,910	71,563
16	(14)	General Motors Corp.	95,985	81,595
17	(13)	Radio Corp. of America	88,200	91,996
18	(15)	Avco Corp.	82,724	80,781
19	(24)	Hercules Powder Co.	72,665	36,633
20	(20)	Bendix Corp.	71,460	61,509
21	(21)	Hughes Aircraft Co.	58,742	60,445
22	(31)	Philco Corp.	57,643	24,996
23	(17)	Space Technology Lab. Inc.	51,366	76,907
24	(19)	Raytheon Co.	45,198	69,473
25	(33)	I B M	38,609	20,554
26	(22)	American Bosch Arma Corp.	37,279	56,031
27	(34)	Ford Motor Co.	35,135	20,109
28	(30)	Sylvania Electric Products, Inc.	29,237	26,191
29	(25)	Northrop Corp.	27,671	34,621
30	Not Listed	Aro, Inc.	26,399	.....
31	(23)	Goodyear Aircraft Corp.	25,265	40,351
32	(28)	Minneapolis-Honeywell Reg. Co.	24,922	27,121
33	(36)	Fairchild Stratos Corp.	23,290	16,593
34	(41)	Vitro Corp. of America	22,323	11,907
35	(29)	American Machine & Foundry Co.	20,069	26,782
36	(27)	Thompson Ramo Wooldridge Inc.	17,262	33,177
37	(38)	General Tire & Rubber Co.	15,136	14,644
38	(69)	Alpha Corp.	14,874	4,974
39	(43)	Cutler-Hammer Inc.	13,810	11,390
40	(72)	Kaman Aircraft Corp.	13,780	4,623
41	(124)	Republic Aviation Corp.	12,815	1,513
42	(87)	Eastman Kodak Co.	12,045	3,214
43	(42)	McDonnell Aircraft Corp.	11,692	11,398
44	(40)	Marquardt Corp.	11,461	12,478
45	(65)	Bell Aerospace Corp.	11,266	5,491
46	(44)	Motorola Inc.	10,539	10,076
47	(88)	Texas Instruments, Inc.	10,431	3,122
48	(32)	Burroughs Corp.	10,173	23,263
49	(70)	ACF Industries, Inc.	8,883	4,970
50	(102)	Hazeltine Corp.	8,675	2,563
51	(48)	Curtiss-Wright Corp.	8,613	8,905
52	(52)	Sanders Associates, Inc.	8,583	8,309
53	(80)	Aircraft Armaments, Inc.	8,453	3,636
54	(45)	Hoffman Electronics Corp.	8,322	9,874
55	(49)	Fairchild Camera & Instr. Corp.	8,274	8,831
56	(47)	General Precision, Inc.	8,112	9,043
57	(90)	Control Data Corp.	7,416	2,965
58	(50)	Land Air, Inc.	7,302	8,789
59	(46)	Chance Vought Corp.	7,142	9,866
60	(162)	Geotechnical Corp.	7,036	1,014
61	(39)	Litton Systems, Inc.	6,928	13,882
62	(393)	Yardney Electric Corp.	6,715	245
63	(37)	Collins Radio Co.	6,163	16,366
64	(76)	Gilfillan Brothers, Inc.	5,964	4,249
65	Not Listed	F.M.C.	5,705	.....
66	(79)	Varian Associates	5,564	3,793
67	(59)	Melpar, Inc.	5,382	6,271
68	(58)	Acoustica Associates, Inc.	5,126	6,272
69	(64)	Atlantic Research Corp.	4,928	5,664
70	Not Listed	U.S. Underseas Cable Corp.	4,862	.....
71	(55)	Hallicrafters Co.	4,761	7,289
72	(78)	Edo Corp.	4,706	3,903
73	(39)	Litton Industries Inc.	4,663	13,882
74	(255)	Solar Aircraft Co.	4,498	516
75	(133)	Continental Avia. & Eng. Corp.	4,486	1,380
76	(74)	Callery Chemical Co.	4,153	4,463
77	(84)	Cubic Corp.	4,130	3,388
78	(57)	Little (Arthur D.) Inc.	3,823	6,655
79	(73)	General Mills, Inc.	3,812	4,520
80	(112)	Minnesota Min. & Mfg. Corp.	3,585	2,017
81	(137)	Huyck Corp.	3,530	1,344
82	Not Listed	Northern Ordnance, Inc.	3,489	.....
83	(61)	Union Carbide Corp.	3,384	6,193
84	(129)	Federal Electric Co.	3,167	1,415
85	(67)	Cook Electric Co.	3,135	5,165
86	(75)	Rohm & Haas Co.	2,923	4,309
87	(109)	Garrett Corp.	2,893	2,155
88	(86)	Maxson Electronics Corp.	2,806	3,248
89	(100)	Telecomputing Corp.	2,535	2,601
90	(83)	Ryan Aeronautical Co.	2,521	3,397
91	(54)	Magnavox Co.	2,505	7,342
92	(144)	National Co., Inc.	2,481	1,223
93	(62)	Chrysler Corp.	2,466	6,123
94	(108)	Belock Instrument Corp.	2,373	2,156
95	(171)	National Cash Register Co.	2,287	920
96	(95)	Technical Operations, Inc.	2,232	2,822
97	(89)	Electro Optical Systems, Inc.	2,182	3,058
98	(117)	Esso Research & Engineering Co.	2,155	1,720
99	(101)	Dow Chemical Co.	2,109	2,574
100	(121)	United Electro-dynamics, Inc.	2,106	1,607

*Position in FY '60

Increased technical responsibilities in the field of range measurements have required the creation of new positions at the Lincoln Laboratory. We invite inquiries from senior members of the scientific community interested in participating with us in solving problems of the greatest urgency in the defense of the nation.

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—reviews—

ALLOYING ELEMENTS IN STEEL, 2nd Edition, Edgar C. Bain and Harold W. Paxton. American Society for Metals, Metals Park, Ohio. 340 pp., $9.50.

Originally published in 1939, the volume has been completely reviewed and revised to reflect metallurgical advances in the past 20 years. It now covers recent research in iron-alloy equilibrium diagrams, as well as recent theory on martensite and its tempering.

Contents include chapters on "Fundamental Characteristics of Steel," "Alloying Elements in Unhardened Steel," "Effects of the Elements in Hardening Steel," and "Effects of Alloying Elements in Tempering."

APPLIED OPTICS, new bimonthly journal of the Optical Society of America, 1155 16th St. N.W., Washington 6, D.C. Subscriptions: OSA members, $8 per year; nonmembers, $10 per year.

The first issue concentrates on "Optical Pumping and Masers." A slick magazine following traditional tech-journal format and content, it presents some of the better research papers of 1961 in the laser field.

Among the 11 papers presented are details on optical pumping; composite-rod, ruby and hydrogen masers; a new approach to Fabry-Perot interferometer use in lasers (paper in French); plus several papers on laser materials.

PLASMAS AND CONTROLLED FUSION, David J. Rose and Melville Clark, Jr. M.I.T. and John Wiley & Sons, Inc., New York. 493 pp., $10.75.

Presented in this graduate-level textbook are the principles underlying plasma physics and controlled fusion.

The first 12 chapters cover plasma physics, hydromagnetics, and elementary gaseous electronics in association with transport and electromagnetic theories. The last four chapters deal with the controlled fusion problem, including experimental and theoretical approaches, and methods of eventual energy recovery.

AIR FORCE SCIENTIFIC RESEARCH BIBLIOGRAPHY, Vol. 1. Order from Superintendent of Documents, U.S. Government Printing Office, Washington 25, D.C. Qualified requestors may obtain copies from the Armed Services Technical Information Agency, Arlington Hall Station, Arlington 12, Va. 1150 pp., $6.75.

This is an extensive bibliography of abstracts of Air Force-supported basic research projects accomplished between 1950 and 1956.

The collection of over 4000 basic research summaries is the result of a manual search of technical libraries, government repositories and 45 domestic and foreign professional journals and other scientific publications.

In addition to a detailed alphabetical subject index, the entries are indexed by contractors, authors, and AFOSR control numbers. All entries are coded for direct input into automatic information storage and retrieval system.

soviet affairs

By Dr. Albert Parry

Use of rockets to change the Earth's climate

is suggested by V. B. Cherenkov, a Soviet engineer. His proposal, as summarized by V. Komarov in *Krasnaya Zvezda,* the armed forces daily, is aimed at "the betterment of the Earth's climate through the utilization of those sun-rays which presently travel past our planet." Rockets can be used, Cherenkov declares, to create around the Earth a huge flat ring composed of tiny dust particles which would improve our climate by "intercepting such sun-rays, directing them to the Earth, and thus furnishing the Earth's surface with additional warmths." The ring should be placed in such a way as to bring far more of this supplementary heat into our polar regions than to our equatorial areas.

A new anti-corrosion lubricant

is reported in *Krasnaya Zvezda* as being greatly superior to any other yet known, certainly better "than the so-called consistent lubricants." Developed by the researchers of the Soviet petroleum industry, and called "Neftegaz-203," the new lubricant "contains the chemical substance known as inhibitor." Every kind of metal and alloy is said to respond to the new lubricant much better than to any older oil.

Cobalt can eventually be mined

from the floor of the earth's oceans, Professor G. A. Krutov states in his book *Mestorozhdeniya Kobal'ta* (Cobalt Deposits). He estimates the Earth's accessible surface deposits of cobalt at one million tons, and argues that should man in time evolve methods of mining the ocean floors he would reach a total of nearly two billion tons of cobalt. These below-water deposits, he explains, are concentrated in "iron and manganese concretions."

What is the moon made of?

Its upper stratum consists not of basalt, "as it was earlier thought," but basically of diorite, granite, and gabbro, says Professor V. Troitsky of Moscow, a doctor of physics and mathematics, in reporting on his and his staff's investigations of the moon through radio-waves. He refutes "the opinion predominating until now that the moon's upper cover is an ocean of jagged dust." He adds that it is possible to liken the moon's surface to cotton, since in weight it is twice as light as water.

Lecturers in nuclear physics and radioelectronics

as well as rocket technology are being regularly given to officers and men of the Soviet rocket troops, according to *Krasnaya Zvezda.* And the daily of Communist Youth League, *Komsomolskaya Pravda,* maintains that by December, 1961, almost every member of the Soviet rocket troops had a minimum education of 10 years (equivalent to a U.S. high school graduation) or a technicum (roughly equal to our manual training school).

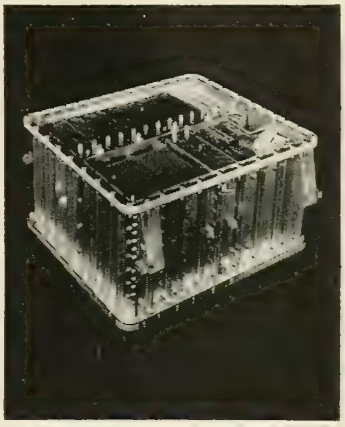
New Soviet books on rocketry

include *The English-Russian Dictionary of Anti-Aircraft and Anti-Rocket Defense,* which will appear soon, and the recently issued 56-page booklet entitled *The Battle Use of Antitank Guided Missiles* by V. M. Shaikov and V. I. Yevdokimov. The publisher of both is Voyenizdat (the Military Publishing House in Moscow).

Russian training methods for Enos

assured the success of the American space-traveling monkey. This assertion is made by S. Kondrashov in *Izvestia.* He writes that, to elicit from Enos those proper responses to light signals during the rocket flight, the U.S. monkey "had been trained according to the Pavlov system of conditional reflexes."

This Univac computer measures just one cubic foot! It is a powerful, general purpose space-borne computer, utilizing thin film memory, welded connectors and encapsulated circuit modules which have been designed for extreme reliability and adaptability to numerous severe environmental space and airborne applications. Career opportunities inherent in such projects are obvious, and qualified applicants are urged to investigate them immediately.



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AIR FORCE

$49,498,780—**General Dynamics Corp.**, San Diego, for installation and checkout of F-series *Atlas* missiles and for engineering design, development and fabrication of *Atlas* boosters (2 contracts).

$13,491,630—**General Electric Co.**, Philadelphia, for development and fabrication of the *Titan II* re-entry vehicle, for design and production of intercomplex communications system for the *Titan II*, and for installation and checkout of *Atlas* missiles (4 contracts).

$6,211,773—**General Electric Co., Defense Systems Department**, Syracuse, N.Y., for precision trajectory measurement system.

$5,472,000 — **Aerojet General Corp.**, Sacramento, Calif. for research and development of an improved stage II *Minuteman* motor, for logistic support of the *Titan* test program, and for spare parts and ground equipment for *Titan* propulsion systems (3 contracts).

$4,900,000—**Radio Corp. of America**, Moorestown, N.J., for work on the BMEWS system (supplemental contract).

$3,944,682—**North American Aviation**, Downey, Calif., for spare parts for *Minuteman* guidance systems and for *Atlas* propulsion systems.

$3,450,000—**Lockheed Aircraft Corp.**, Sunnyvale, Calif., for research and development for space satellite vehicle programs (supplemental contract).

$2,736,140—**North American Aviation, Inc.**, Canoga Park, Calif., for support of a NASA rocket engine program (supplemental contract).

$2,366,700 — **Raytheon Co.**, Waltham, Mass., for production of electronic tubes for a radar system.

$2,250,000 — **General Dynamics Corp.**, San Diego, for ground equipment for *Atlas* missiles.

$2,006,400 — **Space Technology Laboratories, Inc.**, Los Angeles, for systems engineering and technical direction for the *Atlas*, *Titan* and *Minuteman* systems.

$1,665,000—**Martin Marietta Corp.**, Denver, for follow-on support and establishment of a rapid communication system for *Titan I* missile system.

$1,500,000—**Hercules Powder Co.**, Wilmington, Del., for research and development for an improved stage III *Minuteman* motor (letter contract).

$1,000,000—**Western Electric Co.**, New York, for design, development and fabrication of a guidance system for the *Titan* missile (supplemental contract).

ARMY

$4,642,448—**Sperry Rand Corp., Sperry Utah Co.**, Salt Lake City, for ground support and missile test items, repair parts, and industrial engineering services for the *Sergeant* guided missile system (10 contracts).

$322,223—**Stolte, Inc.**, Los Angeles, for propellant tank farm at Vandenberg AFB, Calif.

$265,237—**American Astro System**, El Monte, Calif., for shelter shop.

$160,354—**Gilfillan Bros., Inc.**, Los Angeles, for spare parts for the *Corporal* and *Sergeant* guided missile systems (2 contracts).

$136,684—**Douglas Aircraft Co.**, Santa Monica, Calif., for *Nike* field change kits (2 contracts).

INDUSTRY

$1,435,372 — **Arde-Portland, Inc.**, Paramus, N.J., from **Thiokol Chemical Corp.**, for design and manufacture of moveable nozzles and fabrication of heavyweight cases for the *Dyna-Soar* acceleration rocket (3 contracts).

$1,422,000—**Barnes Engineering Co.**, Stamford, Conn., from **Lockheed Missiles and Space Co.**, for horizon sensors for *Agena* space vehicles.

$420,000—**Motorola, Inc.**, Scottsdale, Ariz., from **Boeing**, for electronic parts for *Bomarc B*.

NASA

$26,000,000 — **Aerojet-General Corp.**, Azusa, Calif., for further development of the nuclear-powered rocket *NERVA* (joint contract with AEC).

$590,000—**University of California**, Berkeley, for a four-year study and assessment of the physiological hazards of space flight.

NAVY

$32,426,000 — **Westinghouse Electric Corp.**, Pittsburgh, for nuclear reactor components for *Polaris* submarines.

$9,997,700—**Applied Physics Laboratory**, Silver Spring, Md., for continued research and development work on the *Bumblebee* missile program.

$2,954,367—**Marine Division, Sperry Gyroscope Co.**, Syosset, L.I., N.Y., for management of SINS program.

$1,000,000—**General Electric Co.**, Pittsfield, Mass., for portable test equipment for guidance system checkout in connection with the *Polaris* program.

$690,762—**Maino Construction Co., Inc.**, San Luis Obispo, Calif., for construction of *Polaris* "pop-up" facilities at San Clemente Island, Calif.

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The following is a partial list of Mil-Spec categories available:

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☐ GLASS & GLASS PRODUCTS ☐ FASTENERS & HARDWARE ☐ METALS & METAL PRODUCTS
☐ ELECTRONIC EQUIPMENT ☐ WOOD & WOOD PRODUCTS ☐ INSPECTION METHODS & PROCESSES
☐ FUEL OIL & GREASE ☐ RUBBER & RUBBER GOODS ☐ PACKING & INSULATING MATERIALS

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Each set consists of two (2) volumes of approximately 1500 separate drawings describing standard parts or assemblies. Drawings are numbered from AN 1-9999. These parts are the most commonly used by Air Force/Navy Activities in procurement of Aircraft, Guided Missiles, Electronics and Ground Handling Equipment.
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These drawings consist of engine and propeller standard parts. Drawings are numbered from AN 100,000. These drawings are intended for use in power plants. However, they may be used in the design and construction of airplanes and associated equipment.
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INDEX (Department of Defense)
This index of specifications and standards supersedes all other volumes of military indexes. Includes alphabetical and numerical listings with cumulative monthly supplements for one year. Approximately 900 pages.
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New Product of the Week: Voltmeter/Ratiometer

A combination d-c digital voltmeter and ratiometer has been developed by Cohu Electronics, Kin Tel Division.

Four automatically-selected ranges permit voltage measurement between ±100 microvolts and ±1000.0 volts, ratios between ±0.0001:1 and ±999.9:1. Measurement range, decimal point placement, and polarity or ratio symbol selection are all automatic and accurate within 0.01% of the indicated value ±1 digit.

Any external reference between ±1 and ±100 volts may be used. Positive or negative references may be used simultaneously, and the internal circuits will select automatically the reference having the same polarity as the unknown input.

Circle No. 225 on Subscriber Service Card

Wedge-Action Relay

A Mark II Type 1000 series of relays that meets the requirements of MIL-R-5757 D for 125°C operation are available from Electro-Tec Corp. The relay incorporates the patented "Wedge Action" principle, proven as the principal design feature of the Mark II Type 2000 series, rated at 200°C, and is available at a considerable reduction in price. For applications not requiring the ability of the Type 2000 Mark II relay to withstand extreme temperature (up to 200°C), the unit offers substantial economies.

Circle No. 226 on Subscriber Service Card

Electro-Hydraulic Forming

General Electric Co. is marketing electro-hydraulic power equipment which shocks hard-to-form metals into shape for Space-Age products.

The metal-forming units utilize electric arcs instead of conventional chemical explosives to fabricate titanium, niobium, columbium, stainless steel, tungsten, and beryllium alloys. The equipment is adaptable to installation in a production line, requires a rather small die and facilities investment, operates in a simple, repetitive fashion and features extremely high-accuracy of part reproduction. The development eliminates explosion shelters, special handling methods and other time- and cost-consuming procedures usually associated with explosive forming.

Circle No. 227 on Subscriber Service Card

Feed Back Servo

A low cost, motor speed control unit incorporating a feed back signal in a servo loop has been introduced by the Controls Division of Copy Research Corp. Constant torque at all speeds is provided through the use of the servo principle. Precise speed control is maintained regardless of wide load fluctuations. Motor speed may be varied over a 15:1 speed range and reversed without change in torque. The unit combines miniaturization with adaptability and reliability and may be used as a portable or panel-mounted instrument.

Circle No. 228 on Subscriber Service Card

Acceleration Switch

The Polomar acceleration switch, a product extension of the basic servoed linear accelerometer, has been developed by Palomar Scientific Corp. The single-axis accelerometer delivers a continuous voltage analog of acceleration to voltage detector which produces an output to actuate the switching element when the input acceleration has attained a preset level. Applications include g-limiting, detection of first motion at launch, stage separation indication, detection of atmospheric re-entry and others. A versatile choice of solid state and relay output switching elements is available.

Circle No. 229 on Subscriber Service Card

Conductive Plastic

Chomerics, Inc., has developed conductive plastic system whose performance is equivalent to the expensive gold- and silver-filled plastics now being used. This system can be used as a paint, ink, solder, or molding resin. Conductivities can be controlled in the range of 100 to 0.01 ohm-centimeters.

Circle No. 230 on Subscriber Service Card

Operational Amplifier

Navigation Computer Corp. is producing a Model 3PA6G Operational Amplifier. The Model 3PA6G is a high-gain d-c amplifier which is designed for maximum versatility in data-handling systems. The mitter follower output stage can be connected either in phase or out of phase with the input; and feedback brought back to the input, giving a low input impedance, or to the

Four outstanding Boeing openings in

METROLOGY

The Boeing Primary Standards Laboratory in Seattle is expanding into a new laboratory building that will provide measurement facilities and capabilities unsurpassed in private industry. This continuing growth has created immediate openings that offer exceptional opportunities for professional advancement:

ACOUSTICAL ENGINEER

This position, requiring a B.S. or advanced degree in Physics, Mathematics or EE, involves research, investigation and implementation of measurement systems and techniques for acoustical standards. Experience in instrument analysis or development required.

MECHANICAL ENGINEER

Duties involve the development and implementation of precision measurement equipment calibration techniques. Should have a B.S. or advanced degree in ME or equivalent, with applicable experience in machine shop, gauge design or quality control.

PHYSICIST-ELECTRICAL ENGINEER

Responsibilities include development of facilities, techniques and procedures for magnetic measurements. Requirements include an engineering degree, plus experience in precision measurement instrumentation. Advanced degree desirable.

HIGH FREQUENCY MEASUREMENT ENGINEER

A B.S. or advanced degree in EE or Electronics is required for this position, which involves assignments to develop and implement measurement equipment and calibration techniques. Four years of applicable experience is essential.

Please telephone collect, Mr. Jim O'Bannon, at JUniper 5-4611, Seattle, for further information. If you are unable to call, send your resume to Mr. Carl A. Anderson, The Boeing Company, P. O. Box 3707 - MRL, Seattle 24, Washington. Boeing is an equal opportunity employer.

BOEING

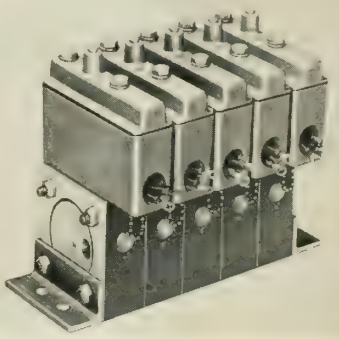
opposite side of the first-stage difference amplifier, giving a high input impedance. Matched silicon input transistors are cemented in a common heat sink for minimum drift.

Circle No. 231 on Subscriber Service Card

Miniaturized Control Valves

A series of slim line miniaturized control valves has been announced by Bellows-Valvair, Division of IBEC.

Designed for "building block" applications, the valves feature small envelope dimensions, and flow rates of up to 16 cfm @100 psi, exhausting to atmosphere. Suitable for manual, sole-



noid or remote pilot actuation they can be mounted singly for control of jigs or fixtures and are designed for air, oil or water service, at pressures up to 125 psi and temperatures to 150°F.

Circle No. 232 on Subscriber Service Card

Nylon Abrasives Deburring

Moog Servocontrols Inc. has developed discs of non-woven nylon fabric impregnated with very fine silicon carbide abrasive and driven by high-speed grinders at 60,000 rpm. The flexible nylon material conforms so readily to stepped or tapered holes and threaded areas that internal diameters are finished more smoothly, with zero disturbance of critical dimensions. Each bench hand die-punches out discs or squares of the proper size as needed; since wear slowly reduces the discs, they are used in progressively smaller orifices.

Circle No. 233 on Subscriber Service Card

Pressure Transducer

Dynisco Division of American Brake Shoe Co. is marketing a bi-directional differential pressure transducer designed for hydraulic pressure measurement in airborne missile environments and ground-test check-out programs.

The PT98D has a very-high-frequency response and small internal volume, and possesses excellent stability under severe environmental conditions. It utilizes two mechanically independent pressure capsules, connected electrically to form a differential pressure transducer. It features a low common-mode signal, high overload protection, and extremely good linearity and hysteresis (.5% F.S.). Its vibration sensitivity is negligible.

Circle No. 234 on Subscriber Service Card

Automatic Leakage Tester

An automatic continuity and leakage tester which speeds up circuit checkouts through automated techniques is being marketed by Datronics Engineers, Inc., through its Strand Engineering Co.

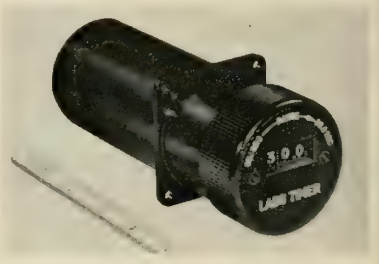
Designed for use wherever electronic equipment is manufactured, maintained or used, the tester can significantly improve product reliability through the uniformly rigid inspection criteria built into the tester.

Featuring large capacity and flexibility of usage, it provides for simultaneous continuity and leakage checking of 1000 circuits (2000 points), with full branch circuit capability.

Circle No. 235 on Subscriber Service Card

Digital Timer

A timer has been manufactured by Globe Industries, Inc., with digital 0.1 second increment presentation, with times from 00.0 to 30.0 seconds, and is accurate to ±0.1 second or ±1% of the set time. It requires no warm-up, automatically resets when the power is switched off, provides two switching



functions capable of 5 ampere resistive loads, operates from −55°C to 71°C, uses a governed dc motor drawing 18 watts at 27 vdc and meets appropriate military specifications. Weighing under 2 pounds, the timer is 6.205 in. long by 2.265 in. diameter.

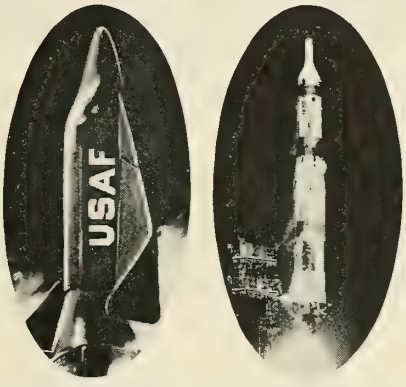
Circle No. 236 on Subscriber Service Card

Heatless Dryer

A heatless dryer for producing clean, pure, extremely low-dewpoint air and other gases is announced by Applied Pneumatics, Inc. The unit meets all MIL specifications and is used for cooling electronic devices, instrument air drying, radar pressurization and other industrial, military and laboratory applications.

Circle No. 237 on Subscriber Service Card

MILITARY SPACE SYSTEMS



Another first for MISSILES AND ROCKETS, presenting all the nation's military space projects and programs in a single package in

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The military space budget
is expected to more than double in '62
and the upward trend will continue.
In M/R's highly successful NASA issue, published November 27, 1961, M/R's editors totally covered NASA's programs and projects.
On March 26, 1962, M/R will publish its second annual Research and Engineering issue, the companion to the NASA issue. In it, M/R's editors will cover the military space budget, programs and projects, personnel, facilities, and contracting procedures—with emphasis on what the military will buy in the future.
And most important . . . M/R will provide an *Industry Guide to the Military Space Centers.*

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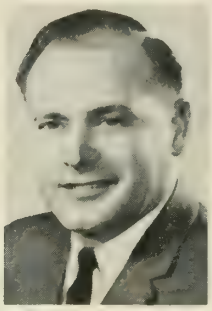
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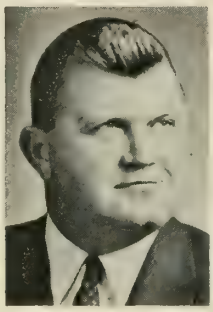
OSKIN

O'CONNOR

S. W. Towle, Jr.: Senior eastern officer of Northrop Corp.'s Washington, D.C. office, has been promoted to corporate vice president. Also, **Frank W. Lynch** was made vice president and manager of the Systems Support Department, Anaheim, Calif., and **Ross F. Miller** was named vice president and manager of the Electronic Systems and Equipment Department, Hawthorne and Palos Verdes Estates, Calif.

Matthew W. Urlaub: Named project manager for the advanced *Saturn* booster at the George C. Marshall Space Flight Center.

Dr. William J. Perry: Director of the Electronic Defense Laboratories, Sylvania Electric Products Inc., has been awarded the Outstanding Civilian Service Medal by the Department of the Army for his contributions to the development of highly sophisticated electronic warfare systems and equipment.

Roger HB. Davis: Elected vice president and comptroller of Servonics, Inc., Alexandria, Va.

Myron R. Prevatte: Named a vice president of General Precision's Librascope Division, and will continue to direct operations of the Division's Washington, D.C. customer relations office.

H. Douglas Lowrey and **Everett M. Scranton:** Appointed vice presidents in the Chrysler Corporation Space Division. Lowrey will be in charge of operations and Scranton will be vice president-administration and comptroller. Both will be located in the Space Division headquarters at NASA's Marshall Space Flight Center.

Kenneth M. Miller: Appointed general manager of Singer-Bridgeport, Military Products division of The Singer Manufacturing Co., Bridgeport, Conn.

Grant L. Hansen: Former chief engineer-design, has been promoted to vice president of General Dynamics/Astronautics. He will direct the *Centaur* program. Other executive appointments in the expanded *Centaur* department are: **Edward J. Bryant,** manager of material; **G. Deane Davis,** chief of engineering; **Kenneth W. Jeremiah,** deputy program director, *Centaur* program control; **Larry G. Granstedt,** manager of operations; and **William R. Monroe,** manager of reliability control.

Donald C. Oskin: Elected vice president of Marketing of FMC's chemical divisions, New York City.

G. Paul McCormick: Former assistant to the president, has been made a vice president of North American Aviation's Columbus Division, Ohio. He will direct the division's missile, trainer aircraft, and surface-based electronic systems programs.

Robert B. Muchmore: Will direct a new Physical Research Division at Space Technology Laboratories, Inc., Los Angeles, **Dr. David B. Langmuir** was named associate division director. Also, **John F. Mandrow** has been made director of STL's BAMBI (Ballistic Anti-Missile Boost Intercept) study program and will be assisted by **Irwin Pfeffer** as associate study director.

Col. Edmund F. O'Connor: Designated to head the new Systems Project Office for development of a mobile mid-range ballistic missile (MMRBM) at the Los Angeles Headquarters of the Ballistic Systems Division of Air Force Systems Command.

Dr. Neal M. Burns: Named director, Advanced Life Sciences Division, The Decker Corp., Bala-Cynwyd, Pa.

Bruce A. Winner: New vice president-general manager, Welton V. Johnson Engineering Co., Inc., Summit, N.J.

E. Hugh Jones and **Jack L. Mustard:** Elected vice presidents of Ex-Cell-O Corp., Detroit, Mich., Jones as vice president-Manufacturing Group, and Mustard as vice president-Precision Parts and Assemblies Group.

Fred M. Winnai: Sales manager of Intercontinental Dynamics Corp., Englewood, N. J., has been advanced to the position of a vice president of the company.

Eugene G. Rochow: A professor of inorganic chemistry at Harvard University, was presented with the Perkin Medal Award, one of America's highest honors for applied chemistry, by the American Chemical Society. The award was given in recognition of his work in the early research in silicone chemistry at General Electric.

Prof. Frank Verbrugge, acting dean of the University of Minnesota Institute of Technology, assumed the presidency of the American Association of Physics Teachers at the annual meeting in New York City; **Dr. Vincent E. Parker,** Head of the department of physics and astronomy at Louisiana State University, was named president-elect and will take office next year; the new treasurer is **Dr. Joseph Dillinger,** professor of physics at the University of Wisconsin; and **Dr. Ralph P. Winch,** professor of physics at Williams College, was re-elected secretary, **Prof. Francis W. Sears,** chairman of the department of Physics at Dartmouth College, received the Oersted Medal, one of the highest honors of the organization; and **Donald S. Ainslie,** University of Toronto, Canada, **Sanborn C. Brown,** Massachusetts Institute of Technology, **Gerald Holton,** Harvard University, **Thomas D. Miner,** Garden City, N.Y. High School, and **H. Victor Neher,** California Institute of Technology, received Distinguished Service Citations.

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when and where

FEBRUARY

Institute on Information Storage and Retrieval, American University, Washington, D.C., Feb. 12-16.

International Solid State Circuits Conference, Philadelphia, Feb. 14-16.

Sixth Annual Meeting of the Biophysical Society, American Institute of Biophysical Sciences, Sheraton-Park Hotel, Washington, D.C., Feb. 14-16.

Golden Gate Metals Conference, Fairmont Hotel, San Francisco, Feb. 15-17.

American Institute of Mining, Metallurgical, and Petroleum Engineers, 91st annual meeting, Hotels Statler and Astor, New York City, Feb. 18-22.

Tracking and Command of Aerospace Vehicles, Institute of the Aerospace Sciences, Jack Tar Hotel, San Francisco, Feb. 19-21.

Electrical Insulation Conference and Exhibit, American Institute of Electrical Engineers, Shoreham Hotel, Washington, D.C., Feb. 19-22.

Society of American Military Engineers Southwestern Regional Conference, El Paso, Tex., Feb. 23.

Third Annual Symposium on Nondestructive Testing of Aircraft and Missile Components (Southwest Research Institute), Gunter Hotel, San Antonio, Tex., Feb. 27-Mar. 1.

Application of Switching Theory in Space Technology, symposium sponsored by Air Force Systems Command, Air Force Office of Scientific Research, and Lockheed Missiles and Space Co., Sunnyvale, Calif., Feb. 27-Mar. 1.

MARCH

Institute of Radio Engineers, 8th Scintillation and Semiconductor Counter Symposium, Washington, D.C., Mar. 1-3.

Pittsburgh Conference on Analytical Chemistry and Applied Spectroscopy, sponsored by the Society for Analytical Chemists and the Spectroscopy Society, Penn-Sheraton Hotel, Pittsburgh, Mar. 5-9.

Fifth Annual Technical Conference Society of Vacuum Coaters, Sheraton-Cleveland Hotel, Cleveland, Mar. 6-7.

Society of American Value Engineers (SAVE) Annual Meeting, Marriott Motor Hotel, Washington, D.C., Mar. 6-7.

Armed Forces Communications and Electronics Association, Cape Canaveral Chapter, symposium, Cocoa Beach, Fla., Mar. 6-8.

Flight Propulsion Meeting (classified), Institute of the Aerospace Sciences, Cleveland, Mar. 8-9.

American Society for Quality Control, Middle Atlantic Conference, Statler-Hilton Hotel, Washington, D.C., Mar. 8-9.

First Microminiaturization Congress and Exhibition, sponsored by American Watchmakers Institute, Hotel Commodore, New York City, Mar. 10-13.

National Electrical Industries Show, New York Coliseum, New York City, Mar. 11-14.

1962 Symposium on Packaging of Chemical Products, sponsored by Manufacturing Chemists Association, Inc., St. Louis, Mar. 13-14.

Goddard National Space Conference, sponsored by the National Rocket Club, Sheraton Park Hotel, Washington, D.C., Mar. 14-16 (Goddard Memorial Dinner on Mar. 16).

American Institute of Electrical Engineers, conference on Extra-High-Voltage Communication, Control and Relaying, Baker Hotel, Dallas, Mar. 14-16.

National Association of Corrosion Engineers, Annual Conference and Corrosion Show, Municipal Auditorium, Kansas City, Mo., Mar. 19-23.

Second National Symposium on Hypervelocity Techniques, Denver Research Institute, University of Denver, Mar. 20-21.

American Chemical Society National Meeting, Washington, D.C., Mar. 20-29.

Society for Industrial and Applied Mathematics Spring Meeting, Cal. Tech., Pasadena, Mar. 23-24.

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A Step in the Right Direction

NATIONAL AERONAUTICS and Space Administrator James Webb now is moving ahead with a broad program designed to bring the talent available in the nation's educational institutions to bear on NASA's space problems—both directly through research grants and indirectly through teaching programs.

One aspect of this is a survey of more than 1000 schools and universities to discover their potential contribution to the space effort.

Last week, Congressman Olin Teague (D-Tex.), chairman of the House Subcommittee on Manned Space Flight, announced agreement between NASA and Texas A&M College for establishment of a pilot development course in space engineering (see p. 15).

Development of the pilot course is only a small part of the overall NASA educational program. Although funded at about $50,000, it carries tremendous significance. For one thing, the program holds considerable potential for alleviation of the engineering shortage in just the manner we discussed on this page last week.

The space engineering program will be set up by Aero Geo Astro Corp., an Alexandria, Va., firm under subcontract from Texas A&M.

The firm's forward-looking president, Kenneth S. Kelleher, has been working closely with NASA Administrator Webb, Congressman Teague and university officials in planning the course. A.G.A. is a space hardware firm, not a scientific group. Kelleher believes strongly that a need exists for just such a space engineering course, as opposed to a space science approach.

He found ready listeners in Webb and Teague.

The pilot curriculum indicates the orientation of the course—covering such subjects as fabrication techniques, power sources, telemetry, structures and spacecraft integration.

"It will help give a man confidence," Kelleher says. "It will let him get his hands dirty and learn something about balancing a payload."

Although undergraduate students will participate in the pilot course, the program is aimed at development of a six-month intensified space engineering course for graduate engineers.

It is intended for eventual training of a number of groups:

- The course will serve as a specialized space engineering course for Texas A&M graduate students headed for employment in the missile/space industry or at NASA's Houston spaceflight center, only 90 miles away.
- NASA can use the course for "retraining" of engineers hired elsewhere in the country for work at Houston or other NASA centers. The planning here envisions NASA tuition money for engineers on the NASA payroll.
- Industry can enroll its engineers in a relatively brief specialized space engineering course, much as it now sends its management staff to courses in such institutions as the Harvard or Stanford business schools.

We would like to suggest one further step in the planning. That is, establishment of a number of industry and/or government-funded fellowships intended to retrain mature engineers for eventual employment in the missile/space field. These should include subsistence grants similar to those set up for professional journalists in the Harvard Nieman and Columbia Science Writing programs.

These would permit the mature engineer with a family to enter the missile/space field from another field with the knowledge that he would emerge from the course an extremely eligible candidate for employment in an area with a promising future and a shortage of suitable engineers.

The project is seen as the model for a program which later may be extended to a number of other universities throughout the nation. Texas A&M authorities also look on it as the first step toward what may become a full-fledged four-year space engineering course which would supplement the school's present aeronautical engineering course.

WE THINK THIS is one of the most promising efforts to date in the missile/space educational field.

"It's Jim Webb's idea and I think he's right," Congressman Teague told us last week. "One of the great wastes of scientific and engineering knowledge lies in the schools throughout the country not associated with the space program.

"I don't think we can possibly accomplish what we're setting out to do unless we tie in the brainpower of colleges and universities with industry."

Eventually, a number of schools probably would develop a four-year space engineering curriculum on their own initiative. But the thing we are trying to beat in the space race is time, as Kelleher points out. This is a very sound effort by a government-industry team to bring such an educational development to early fruition.

We warmly compliment the Messrs. Webb, Teague and Kelleher, and Texas A&M for their part in the program. The industry should offer its fullest support at once.

William J. Coughlin

Do you share his organized impatience?

Tomorrow isn't soon enough to suit him. He wants new answers and new applications now. By constantly challenging the state of the art he keeps it advancing.

If you share his itch for action, come to Northrop where action is a way of life. Work on projects ranging from space guidance and navigation to automatic checkout equipment, from computer design and world-wide communications to laminar flow control.

More than 70 such projects are now in work at Northrop, with special emphasis on the need for operations research analysts, physicists, computer circuit designers and programming engineers. But whatever your specialty, if you're the type of engineer who likes to get things done, Northrop has a place for you.

For more specific information, write to Northrop Corporation, Beverly Hills, California, and mention your special field. You will receive a prompt reply.

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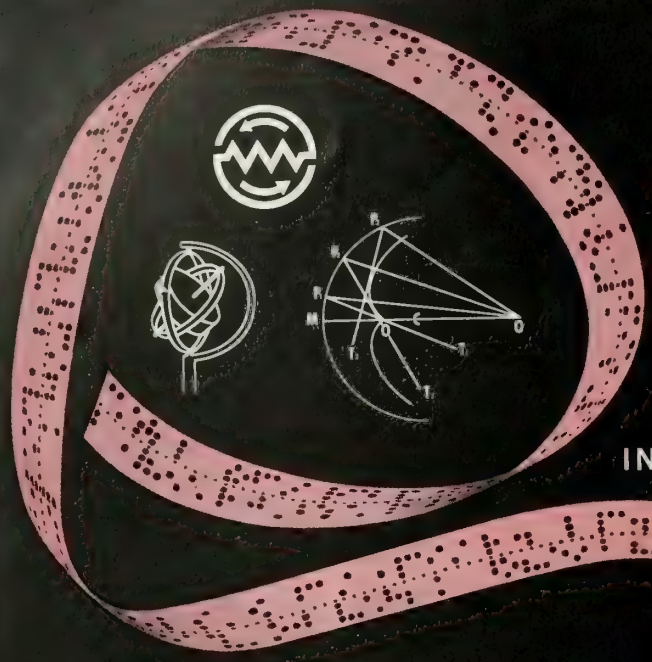

INPUT FROM OUT THERE

Man's comprehension of the cosmos grows with his ability to assess and control the space environment. This is the task of *astrionics*—the discipline that integrates electronics, optics, mechanics, and the information sciences into unified systems.

Aerojet-General's Astrionics Division, manufacturer of the infrared subsystem of the MIDAS satellite, offers complete capability in research, development, and production of advanced astrionic systems for—

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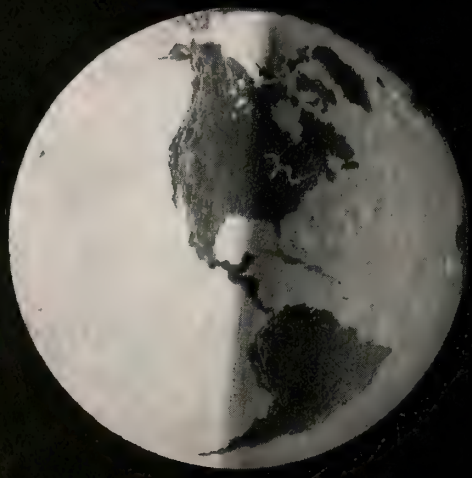
- Target Detection and Identification
- Searching and Tracking
- Electronic Support
- Information Sciences
- Radiometric and Spectral Analysis



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missiles and rockets

THE MISSILE/SPACE WEEKLY

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Nuclear Spacepower: 3-Way Tug-of-Wa
Apollo Lunar-landing Module Award Nea
Bell Readies Launch of First Telstar 22

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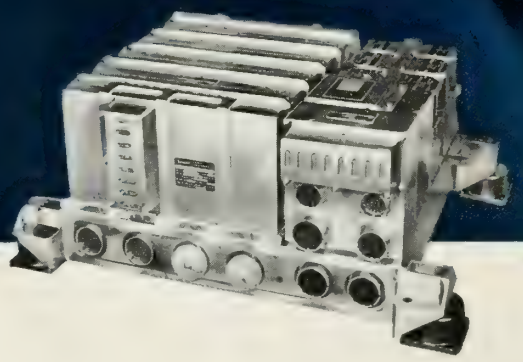

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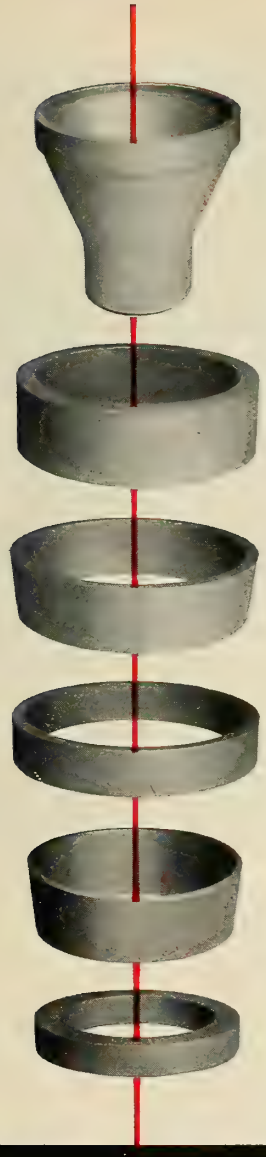

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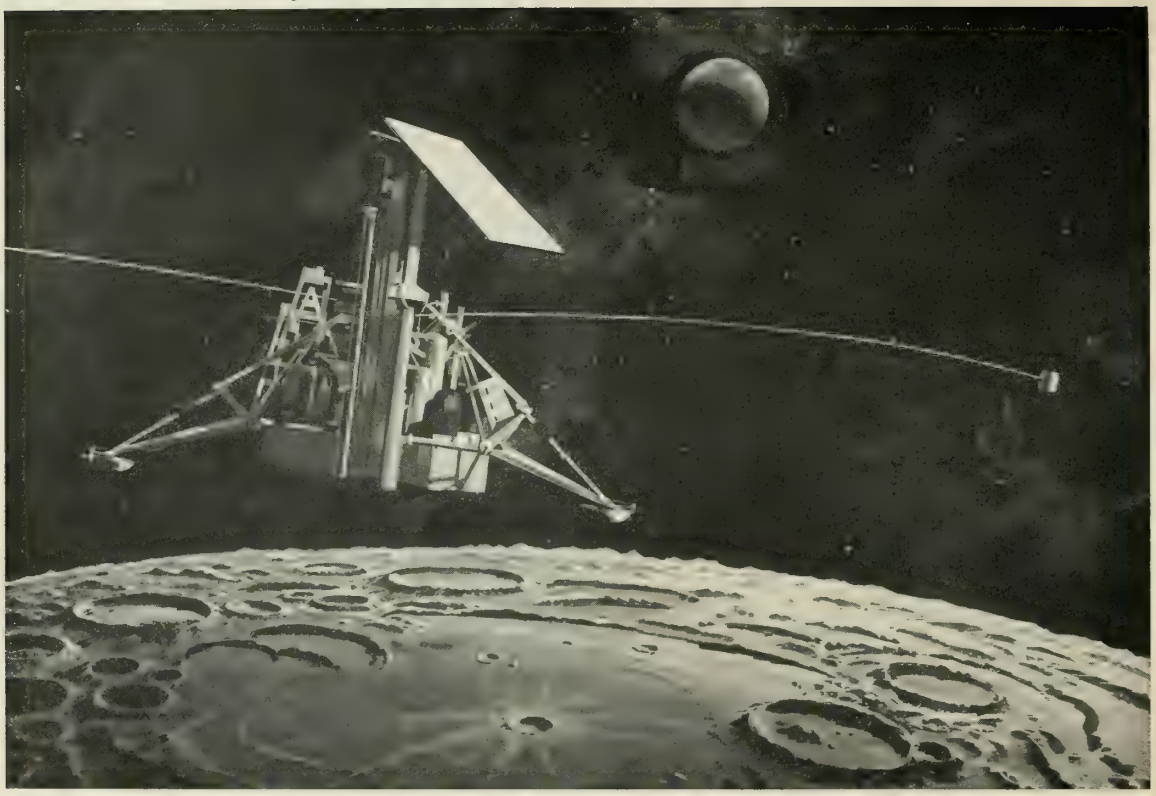

Soft land this vehicle on the moon

This spacecraft is SURVEYOR, one of the many important projects now under way at Hughes. It will "soft" land on the moon sometime in 1963. Its mission: to pierce and analyze the moon's surface; to transmit back to earth high quality television pictures; and to measure the moon's magnetic and radiation characteristics. To accomplish these demanding objectives, Project Surveyor requires the talents of many imaginative junior and senior engineers and physicists to augment its outstanding staff. A degree from an accredited university and U.S. citizenship are required. Experience in Aerospace Vehicles is preferred but not necessary. A few of the openings include:

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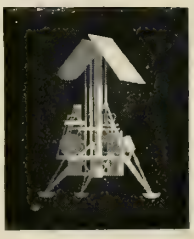

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Volume 10, Number 8 February 19, 1962

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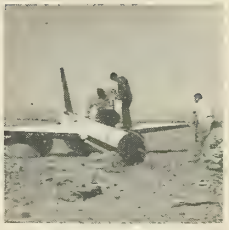
THE COVER

Army's Fairchild Stratos SD-5 surveillance drone after successful flight from Yuma Test Range. Further tests may decide fate of long-range military drones. *See p. 15.*



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letters

Patent Rights Controversy

To the Editor:

The controversy regarding patent rights is amusing. Contractors are moaning that patents are company assets which they should not have to yield to the government. How many of these contractors take the same attitude toward the individual scientists or engineers who invent the devices and methods which the company patents? Do they not take the attitude that they are paying for the time and effort of the inventor, and that they should enjoy the fruits of his mind?

In the same way the government pays the company and deserves the patent to the same extent that the company deserves it from the inventor.

Robert J. Reithel
Los Alamos, N.M.

To the Editor:

May I commend your courage and good sense for publishing such letters as those of Glen C. Horst and Eldon Eller, in your Feb. 5 issue, and that of Rep. Emilio Q. Daddario (D-Conn.), in your Jan. 22 issue, on Industry Patent Practice?

Your advertiser-corporations are the source of your chief revenue, and they will surely frown on such disclosures of their patent practices in dealing with their own engineer-inventors. But it is for *engineers* and *scientists* that your fine publication exists—not top management, to whom technology is usually a closed book. They are occupied with government contracts, profits and losses, stock quotations and the like—including proposed new patent legislation (and mayhap price fixing!).

The corporate employers of creative talent are very ably and valuably represented by their own patent departments in the present controversy over the disposition of patent rights growing out of government-sponsored R&D contracts. They seek to claim those rights, both as employees of the government and as employers of inventive talent—the latter a long-established practice in Big Business.

In both cases, the creative engineer has nothing to say. His position is quite like that of the plantation slave whose (human) offspring was the property of his owner. Even here, procreation is a wellnigh unpreventable manifestation of nature, but inventive creation comes from but a very miniscule portion of our citizenry. It is these who have laid and continue to lay the very foundations of our industry, our well-being, and our National Security.

Yet these most prized among our workers, who "lay the golden eggs" of progress, have practically nothing to say, and for one very cogent reason: they are effectively muzzled by their employment contracts. Only those among them who manage to work effectively as "lone wolves," on their own, alone or in small business, dare speak out against the employer-take-all of corporate patent practices.

Should (employees) do so, they would be dealt with just as effectively as the slaveowner would do with his slaves, should they have the temerity to object to his similar practices. The corporate employee, bound by his contract, willy-nilly signed to be sure, and by his own and his family's security, whatever his inner feelings, dare not publicly evoke them. . . .

As another facet of this controversial situation, we hear much about the extraordinarily high annual rate of employee turnover, as high as 30% in some fields, and the top-talent piracy or highjacking between corporations.

Is this not also due to the fact that employers demand all patent rights from their employees, ofttimes for as much as five years after severance? What stimuli and rewards are there to motivate high-order invention, utmost zeal, and burning of the midnight oil?

These very same corporations who treat their greatest capital assets—i.e., their inventors—so niggardly, think nothing at all of offering extraordinary stimuli and rewards to others of their employees, and outsiders, who *sell* the products created by their inventors.

For example: The *Wall Street Journal* of Jan. 31 reports: "A standard way to give a temporary boost to auto sales is to pay bonuses to dealers, and this Chrysler has done, starting December (1961), by offering a bonus of $50.00 for each car sold to Plymouth and Dodge retailers who order their full 1962 quotas."

If progress, the gross national product, or our defense posture lag, it is high time that corporate industry and our legislators take a long and deep look behind the scenes, and then correct the patent practices which so strongly influence our economy, keeping in mind that our creative citizenry are our chief national asset. It has proved so in the long past; it is doubly so for our future.

Benjamin F. Miessner
(at 71, retired)
President
Patent Equity Association, Inc.
Miami Shores, Fla.

Ranger Capsule Limitations

To the Editor:

In your article, "Ranger—What Might Have Been?" (M/R, Feb. 5, p. 12), you discussed what might have happened if facilities had been available. I think it is also pertinent to speculate on what might have happened had the vehicle been utilized fully.

NASA's failure to launch the landing capsule showed a disturbing lack of imagination and good judgment. At the very least the launch would have served to check out the firing mechanism and performance of the rocket under space conditions. Though firing the capsule in any direction would have been interesting, aiming it either to hit the moon or so that it

would come back to earth could have produced spectacular results.

The moon (diameter 2000 mi.) was less than 23,000 miles away, and aiming the capsule to hit the moon would not have been too difficult. Though the capsule would have been destroyed on impact, like *Lunik II*, this shot would have had propaganda value. Trying to make the capsule return to earth, though considerably more difficult, could possibly have had even greater propaganda repercussions. In either case, launching the capsule would not have meant less scientific data.

In short, I am disappointed in NASA's failure to use all the *Ranger* vehicle's capabilities. They had nothing to lose and a lot to gain. Let's hope for some more imaginative thinking from NASA in the future.

Lon Hocker
Student
Princeton University
Princeton, N.J.

NASA says that launching the landing capsule would have required sending a pulsed signal from the Ranger's altimeter to the moon; when the signal bounced back to the vehicle, the capsule would have been launched. This, however, could have occurred only if the Ranger had been on an impact course and was within 8.1 sec. of impacting the lunar surface. Since there was no possibility of impacting Ranger itself, the "bounce" could not be carried out.—Ed.

Above-par Wives

To the Editor:

Re letter from An Engineer's Wife (M/R, Feb. 5, p. 6) . . .

I too am the wife of an "old" (46) design engineer! We move and shift constantly. My husband has *so much* to offer a company, but we *can't* live in a "captive" salary—he therefore is a "per diem" man, which means he is sent in on design jobs "temporarily." If he applied for a "captive" job he'd be lucky to start at $600.00 per month *before* deductions and, at his age, he wouldn't be promoted fast or far. My husband also spent three years in the War and went back to University after that (majored in Industrial Design—he loves it).

It's a shame the Engineering field isn't on a financial par with other professions. Our local plumber gets more putting in cottage septic tanks than my husband, who does important designing of missiles.

(Wife of a Wonderful Man)
(Name and address withheld on request)

Partial to Fable

To the Editor:

My compliments to you on your cleverly written, perceptive editorial, "Once Upon a Country" (M/R, Jan. 29). I hope you have mailed sufficient copies around Washington.

R. D. Davis
Glendale, Calif.

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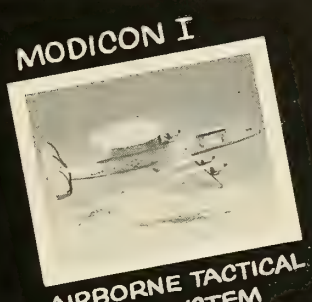

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Engineers, Scientists

what's your opinion:

1

ON HOW TO CREATE A REALISTIC SPACE SIMULATOR?

This is a question put to Bell Aerosystems last year by the Air Force. If you had been a member of Bell's technical staff then, you might have been one of those who developed the space environment simulation concept now being engineered into actuality here. It is based upon a high-resolution, closed-loop television system superimposing images generated by 3 studios. Many stimulating problems, however, remain to be solved in: development of an electronic planetarium, real time digital flight dynamics, television image insetting techniques, TV noise alleviation techniques.

2

ON HOW TO PROVIDE OPTIMUM VEHICLE TOUCHDOWN DISPERSIONS WITH A FULLY AUTOMATIC, ALL-WEATHER LANDING SYSTEM?

Your informed opinions on any aspect regarding landing of boosters or space vehicles will receive thorough consideration. Bell engineers have already created a system in landing conventional aircraft providing a 30% improvement in this area, as demonstrated by 4000 landing tests made by U.S. Navy and Air Force planes. Vehicle landing systems and specialized equipments are advanced concepts now under study.

3

ON HOW TO PROVIDE AN ASTRONAUT WITH POSITIVE, FLEXIBLE STEERING CONTROL IN SPACE?

Your answer will certainly contain the statement that much depends upon the particular space mission but that reaction controls will be the foundation of the system.

This revolutionary concept was originated by Bell engineers for Bell's own X-1B high altitude research plane. More refined Bell Systems were developed for the X-15, Mercury capsule, Agena booster/satellite and Centaur program. Bell's Reaction Controls are applicable to missiles, satellites, re-entry vehicles — indeed, any object requiring a continuous/intermittent or variable thrust vector. One unique recent application is the Bell rocket belt for the infantry man.

The three problems high-lighted above are representative of the wide range of unusual challenges offered engineers at Bell. Others concern such diverse projects as advanced Agena* rocket engines for NASA's Ranger and Marine vehicles; Hydroskimmer (air cushion) amphibians for the U.S. Navy; battlefield surveillance systems; automatic checkout equipment; missile & drone recovery systems. Another important field at Bell is Inertial Guidance and Navigation Systems, many of which employ an appropriate member of Bell's family of Hipernas** inertial platforms. *If you would like to pit your talents against tough-calibre problems, look into current openings with Bell.*

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The Countdown

WASHINGTON

More Missile Base Hearings

Congress is expected to take a new look at the missile base labor situation. Feeling on the Hill: the Labor Department's "no strike" pledge has broken down. This may be tied into a probe of contractor profits, tentatively set for next month.

LeMay Return Ends Rumors

Return of Air Force General Curtis LeMay to Washington to resume his duties as Chief of Staff has put an end to rumors that his illness was serious enough to keep him off the job. The cigar-chewing AF chief spent three weeks in Hawaii convalescing from influenza and a virus ailment. Some Pentagon "insiders," recalling Gen. Hoyt Vandenberg, predicted LeMay wouldn't be back.

Goddard to Head Apollo Net

Despite reports to the contrary, the Goddard Space Flight Center will have primary responsibility for Project *Apollo's* tracking network. Although the space agency's Manned Spacecraft Center at Houston was under consideration, NASA officials decided Goddard is better able to handle the job due to its experience with the *Mercury* net.

How Expensive is Typhon?

Department of Defense officials are taking a close look at the potential cost of the *Typhon* missile system for Navy ships. Defense Secretary McNamara told the Senate appropriations subcommittee last week: "The *Typhon* system promises to be very expensive and we will want to know considerably more about it before we commit it to production."

Agreement on Atlantic Range Operation

A signed agreement between NASA and the Defense Department confirms the Air Force position as range manager in support of the manned lunar landing facilities at Cape Canaveral. This will give AF a voice in the spending of NASA money at the Cape, already earmarked for $359 million in space agency funds in Fiscal '63. NASA will continue to fund the additional land purchases and facilities expansion.

AF Expanding Fight for Space

Air Force is carrying its battle for an expanded space mission to Congress. Gen. Frederick H. Smith, Jr., vice chief of staff, told a closed-door session of the House Armed Services Committee last week that the U.S. faces the possibility of "a great offensive threat from space."

INDUSTRY

Solid-Booster Proposals Due

Proposals for the Air Force segmented solid-propellant rocket booster for *Titan III* are due March 13. Invitations to bid went to Aerojet-General, Thiokol, United Technology, Lockheed Propulsion, Rocketdyne, Hercules Powder and Atlantic Research. One industry source says the RFQ calls for a 121-in. diameter rather than the 120 inches previously set.

Oklahoma, Here We Come

For obvious political reasons, a number of missile/space firms are taking a look at Oklahoma plant sites. North American Aviation has just announced plans for a new facility at Tulsa, and Lockheed also is studying the area.

Second Saturn Soon Under Way

NASA's second *Saturn* booster *(SA-2)* was due to get under way by barge from Marshall Space Flight Center to Cape Canaveral on Feb. 17. Launch date for the big 1.5-million-lb.-thrust vehicle: Early April.

Fuel Cells for Apollo

Pratt & Whitney's Bacon fuel cell has the inside track on the *Apollo* APU contract, soon to be announced by North American Aviation. Next decision to be made in this area: Will there be a backup system and will it be another fuel cell or a cryogenic unit?

Dyna-Soar Decisions Coming Up

Final decisions on the re-directed *Dyna-Soar* program will be made in the Pentagon after a full-scale presentation on the project, now set for April 1. Meanwhile, Category I testing of some *Dyna-Soar* components is under way on the high-speed sled track at Edwards AFB, Calif.

Nuclear Space Power Future

Outlook for use of nuclear power sources in NASA weather satellites is uncertain. First to go nuclear might be *Nimbus*, with power requirements in the 300-400 watt range. NASA officials still have not laid down for the Atomic Energy Commission a specific *SNAP* power requirement. Indications are that the weather satellites will not use a nuclear source until the 1964-65 period.

Late Details on Nova

NASA officials say the *Nova* superbooster will be 280 ft. tall, with a diameter of some 50 ft. It will carry more than 3000 tons of liquid oxygen and kerosene. The second stage, with four M-1 engines, will have the same diameter and will carry about 1000 tons of liquid hydrogen and liquid oxygen.

INTERNATIONAL

Whose Vault Was This?

Material for the fiberglass pole used by Marine pole vaulter John Uelses in setting his 16-ft. world record resulted from a search for better materials for missiles. The California manufacturer reports, according to the *Washington Post*, that at least four of the poles already have been shipped to Russia.

QUALITAS
OF WHAT KIND?

Man's continuing progress in space has placed increasing demands upon the fabricator of missile and rocket components. No longer can the purchaser of structural materials be content with conventional manufacturing processes or products. Rather he must ask himself "of what kind?" as he looks to the manufacturer for advanced materials guaranteed to meet the rigorous demands of this new era.

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The Missile/Space Week

Shots of the Week

After two straight successes last week with its *Nike-Zeus*, the Army suffered a setback Feb. 12 when the missile destroyed itself seconds after launch from Pt. Mugu, Calif.

The launch of the two-stage anti-missile missile, first-stage operation and separation, and second-stage ignition and powered flight were all normal, the Army reported.

However, in spite of the fact that the missile accepted and correctly executed control commands against a simulated ICBM target from the ground guidance center, an automatic safety device in the bird sensed a deviation from the flight path and terminated the test.

The Air Force had better luck with an *Atlas E* launched from Cape Canaveral Feb. 13. The launch marked the end of the training flights for the improved ICBM.

Carrying a multitude of test instruments in the nose cone, the *Atlas* impacted in its planned target area 7000 miles downrange.

A "one-sweep" attempt to recover the missile's nose cone failed.

Weather Halts MA-6 Shot

The first U.S. manned orbital shot —scheduled for launch Feb. 14—had to be postponed for the eighth time due to poor weather conditions in the capsule recovery area.

Although scheduled for the following day, Lt. Col. John Glenn's long-awaited flight appeared to be off until at least Friday. High waves and a new storm center moving into the Western Atlantic recovery area threatened to force further postponement of the shot.

Construction Bill Goes To Congress

Secretary of Defense McNamara forwarded to Congress last week draft legislation to authorize new Military Construction totaling $1,596,410,000 for the coming fiscal year.

The 1963 construction bill—some $766 million over last year's request —was broken down by services as follows:

—Army: $148,750,000 compared with $157,100,000 in FY '62. Funds are largely for troop housing and maintenance facilities.

—Air Force: $744,353,000 compared with $474,900,000 last year. SAC and TAC operational facilities as well as R&D installation for Air Force Systems Command are the major projects authorized.

—Navy: $206,312,000 compared with FY '62 funding of $140,600,000. The bulk of the money is earmarked for training facilities, troop housing and construction outside the continental U.S.

In addition to the $1,099,415,000 for the active forces, $300 million was programed for Military family housing, $46 million for Reserve Components and $133,517,000 for Defense Agencies and Activities.

The latter item includes construction of facilities for the Defense Atomic Support Agency, Communications Agency, Intelligence Agency, Supply Agency and the National Security Agency.

Strikes Jump, Goldberg Acts

Work stoppages at ICBM bases jumped from 953 man-days in December to approximately 2500 man-days in January, the Administration reported last week.

At the same time it was announced that Secretary of Labor Arthur Goldberg had met Feb. 2 with the leaders of the five construction unions responsible for 97% of the strikes. He reportedly received assurances that enforcement of no-strike pledges would be tightened.

Larson AFB, Moses Lake, Wash., was hardest hit, losing 1589 man-days in January due to jurisdictional disputes between local building trades unions.

Non-Profits Get Conflict Quiz

A House Armed Services Submittee headed by Rep. F. Edward Hébert (D-La.), has sent more than 100 questionnaires to officials of non-profit organizations working for the Defense Department, in an attempt to obtain information on possible conflicts of interest.

The primary purpose of the quiz is to determine whether there is a con-

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flict between an individual's role as an adviser to the government as opposed to his private financial and business interests.

Since non-profit organizations are not an integral part of DOD, they are not subject to President Kennedy's new Code of Conduct for government advisers. However, the proprietary nature of their work has raised serious questions in the minds of government officials concerning potential conflicts of interest.

Hearings on the results of the current study will probably be held later this year.

Winter IRE Meeting

The U.S. electronic countermeasures program will be of major importance to industry because "today's excellent electronic sensing or communicating machine is made obsolete by tomorrow's counter-device," Vice Adm. Robert B. Pirie, deputy chief of Naval Operations, told the third National Winter Convention on Military Electronics in Los Angeles.

Aerospace Control Environment (ACE) was emphasized as a new term in the electronics vocabulary by Maj. Gen. Kenneth P. Bergquist, Electronics Systems Division commander, in his address to the annual convention.

He defined ACE as the goal of a complete, thoroughly integrated system complex for centralized control of all activities in the continuous medium from the surface of the earth to "the infinite reaches of space."

Other convention speakers:

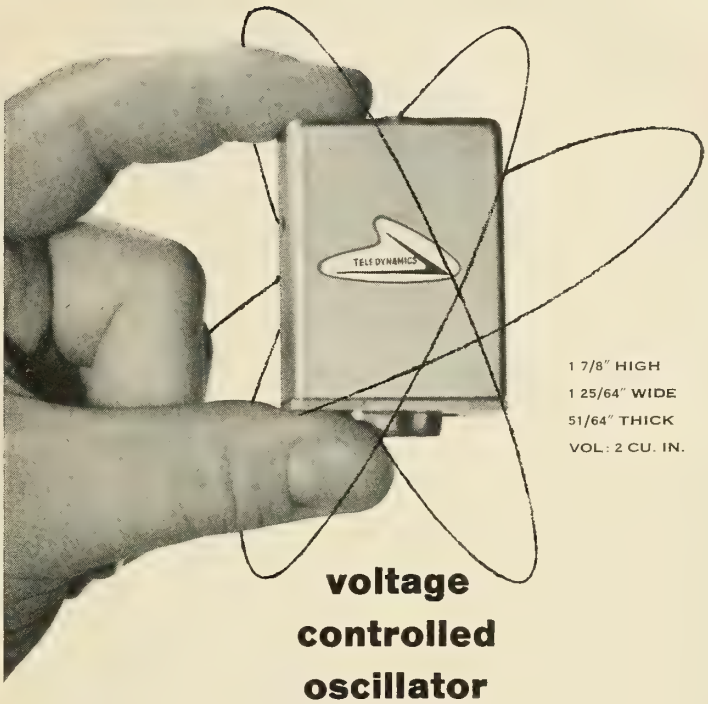
—Assistant Defense Secretary John Rubel, who said no sudden shifts are expected in Pentagon procurement policy.

—Dr. James Wakelin, assistant secretary of Navy for research and development, who stressed the need for the industry and government to work together toward better procurement policies.

—Assistant Air Force Secretary Brockway McMillan, who asserted that technical decisions should be made at the policy level before weapons systems specifications are written up and distributed to industry contractors.

—Assistant Army Secretary Finn J. Larson, who reported that emphasis on limited war will cause a proportional shift in Army research and development money.

TELEMETRY BY TELE-DYNAMICS



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Nuclear Spacepower Tug-of-War

SPUR program held up by disagreement over who's to manage R&D of quarter-billion-dollar effort

by William Beller

THE AIR FORCE, Atomic Energy Commission and National Aeronautics and Space Administration are embroiled in a growing three-way jurisdictional dispute over development of an advanced nuclear-power system for space vehicles.

Money and mission are at stake in the tug-of-war in which each organization is pulling to manage research and development of the power system. One immediate result: the Air Force is stymied in its *SPUR* (space power unit reactor) program.

The system in dispute will be the last of the big nuclear space systems for possibly five to ten years. More than $250 million is estimated to be involved.

The organization with the management role therefore will be building a capability that also will ensure continuing participation in all subsequent nuclear space projects. Moreover, it will have a strong voice at the policy level.

• **Background**—Dr. Harold Brown, Director of Defense Research and Engineering, sent a letter last October to Dr. Glenn Seaborg, AEC chairman, asking the Commission to do the reactor R&D in support of the Air Force effort on the *SPUR* program. (*SPUR* is a 300-kw nuclear turbo-electric spacepower system.)

The AEC sent an interim reply saying it was "firming up" its position on this matter and would let the Defense Department know when "we resolve it." The Air Force is still waiting for the Commission's formal answer.

Meanwhile, the Air Force is ready to talk to industry about contracts to support *SPUR* but is being held back by AEC's lack of action on the reactor question. The most important Air Force program is with Garrett Corp.'s AiResearch Div., whose contract runs out in April. This effort is due to be expanded. But the question nettling the Air Force is how far it can let AiResearch or any other company go before infringing on AEC's prerogatives in the reactor field.

• **NASA-AEC understanding** — A "Memorandum of Understanding" between AEC and NASA was signed in the summer of 1960 between John A. McCone, then AEC chairman, and T. Keith Glennan, then NASA administrator. It defined the areas of responsibility of each agency with respect to applying nuclear energy to space missions.

The two agencies agreed that the AEC is "primarily responsible" for developing reactors and components in support of reactors. They also agreed that NASA is "primarily responsible" for R&D on non-nuclear components and for integrating all components into a power system or propulsion system.

The memorandum clearly covers all nuclear power systems and is not restricted to just one, such as *Rover*. Nevertheless, the AEC is now re-examining its mission in the nuclear spacepower field. The discussion recently reached the Commissioner and Assistant Secretary level. Commissioner Robert Wilson told MISSILES AND ROCKETS: "I cannot say when the results of this discussion will be forthcoming."

He admitted that one of the questions under study is whether the AEC should restrict itself just to reactor development or should take on the entire power system. Asked whether this meant that the "Memorandum of Understanding" with NASA was no longer in force, the Commissioner replied sharply, "There is no agreement with anybody on how the tasks should be divided on large nuclear space power except *Rover*." He denied that there is any general understanding.

• **A question of management**—This much is agreed on by all three organizations:

—The prototype of a 300-kw nuclear unit will not be developed until about 1970. It will be a high-temperature Rankine-cycle system.

—The job is an extremely difficult one. There is some doubt that it can be done at all; but this doubt is very small.

—The job will be so costly that it can be done only once and it must be done right.

—All three organizations—Air Force, AEC and NASA—must cooperate in the venture.

—The AEC will develop the reactor and will test the final system. (This is also a legal requirement.)

• **AEC stand**—G. M. Anderson, AEC's Chief of Auxiliary Power Branch, maintains that the reactor is the prime factor governing the shape of a space vehicle using nuclear power.

Furthermore, Anderson says, the conversion equipment is so intimately bound up with the reactor, the AEC is probably in the best position to manage the power-package job.

The AEC also presses its point this way: If there are two prime contractors —the reactor manufacturer and the converter-system manufacturer — then there has to be an integrator. But the integrator would almost have to live at

the reactor plant to do his job right, since the reactor is the key to the system. It would be more economical, therefore, to let the reactor manufacturer be the overall prime, and the AEC be the program manager.

• **NASA stand**—Below the Administrator level at NASA, it is assumed that the "Memorandum of Understanding" firmly divides AEC's and NASA's responsibilities, with NASA as system manager.

Nevertheless, a top-level secret meeting on the subject was held early last month. Reported present: James E. Webb, NASA Administrator; Robert Seamans, Jr., Associate NASA Administrator; and AEC's Seaborg. Up for discussion was the division of responsibility. Webb is said to have gone with Seaborg's idea of giving AEC the management role, while Seamans did not. The problem remained unresolved, but a follow-on meeting was set up. Seaborg is said to have had a similar meeting this month with a high Air Force official.

• **Air Force stand**—The Air Force view, according to a spokesman high in the *SPUR* project, is to design the nuclear-power system to fit into the space-vehicle booster.

Some Air Force policy makers on the *SPUR* program are raising their eyebrows at AEC's "sudden" interest in starting *SNAP 50*. Their feelings were summed up by an officer who said, "We believe that this should be an Air Force program, and that they do what they are told to do by law and what we are not permitted to do—that is, the reactor work."

He added that the Air Force wants to do the systems work because it is the user agency. He said that the Air Force also feels that the problem of getting the nuclear system has more urgency for the military than for NASA. The system would also be more directed to an ultimate use. Unlike NASA's R&D effort on the general problem, "we want research on components directed to the *SPUR* program," he said.

• **Requirements "merry-go-round"**—An AEC official explained that his agency's funding depends on a system of requirements — and that whoever wants a high-power nuclear system must spell out what kind of a system is wanted and its mission. He complained that the AEC is stymied because "nobody has come up with a requirement for so much power by such-and-such a date."

Taking sharp issue with AEC's stand, a NASA spokesman said, "AEC doesn't need requirements. . . . We told AEC we're interested in high-power reactors. No one's holding them back."

AEC'S SEABORG
Feels his agency should be manager.

NASA'S WEBB
Split with associate administrator?

REP. PRICE
Sees "requirements merry-go-round."

The NASA spokesman added, "There's no point in pinning missions on things we don't know we can build." He also observed that the longer the AEC waits for a requirement, the less need there will be for the agency to fill it. Others will have done the work.

A highly placed Air Force scientist echoed the views of NASA on the difficulty of providing a clear-cut requirement for a system nobody knows can be made.

The AEC's initial disinterest in *SPUR*, apparently due to lack of a requirement, led to Air Force backing of the program. An Air Force officer at one time connected with *SPUR* said this is the way it began:

"In November, 1959, the Air Force felt that a program such as *SPUR* should start. We asked the AEC to run feasibility and supporting studies.

"But the AEC was wrapped up in *ANP* and *SNAP* and had neither the funds nor inclination.

"We had a meeting with NASA, ARPA (Advanced Research Projects Agency), and AEC, and said we'd like to go ahead. They said okay. We set on 300-kw as being large enough to significantly extend the art and not conflict with *SNAP;* and small enough to prove feasibility without getting into expensive hardware.

"Today, the program is entirely Air Force funded and directed. NASA is participating with technical comments. The AEC on an 'informal' basis is running the reactor part of the program."

Rep. Melvin Price (D-Ill.) describes the issue as a "requirements merry-go-round."

A member of the Joint Committee on Atomic Energy, he emphasized the stand of the committee: ". . . work should be carried out which holds promise for advancing the technology even though no immediate value or application can be assigned to the concept."

• **The three projects** — The step after *SNAP 8* is known to the Air Force as *SPUR*, to the AEC as *SNAP 50*, and to NASA as an advanced nuclear-power project. The first two systems are conceived to furnish power in the 300-kw to 1-megawatt range, and NASA's project is conceived as an overall study of the high-power problem including the AF and AEC system.

SPUR, like the even-numbered *SNAP* systems, is based on the Rankine thermodynamic cycle.

Prime contractor on *SPUR* is held by Garrett Corp.'s AiResearch Div. Working on the project for a year and a half, the firm is responsible for developing the conversion loop and for systems integration. Electricity is expected

(Continued on page 38)

$100 million plus . . .

Lunar-landing Module Award Due Soon

Decision to use liquids is new blow to solid backers; choice will almost complete contractor team

by Hal Taylor

NASA WILL WIND UP the major portion of its industrial development team for the *Apollo* spacecraft with the award in the near future of a multimillion-dollar contract for the lunar-landing module.

A top space agency official discloses that industrial proposals for the contract will be requested within a month. Selection of the contractor could come as early as mid-April.

NASA has also decided to use liquid propulsion in the module.

This deals another setback to the adherents of solid-rocket motors who recently saw their hopes for early development of large solid boosters dashed by another NASA-DOD decision.

The lunar-landing module will power the spacecraft during moon-orbital and landing phases of the *Apollo* mission.

Its engines will burn liquid hydrogen-oxygen, the official said. Total thrust has not been set, but it will range from 40,000 to 100,000 lbs. The module will be 20 ft. in diameter and 40 ft. long and will weigh 80,000 lbs.

The official refused to estimate total worth of the contract except to say it would be worth more than $100 million.

He said that present plans call for the completion of the first module in late 1964 or early 1965. Ballistic tests will be made in the latter year, and flight tests with the rest of the *Apollo* spacecraft in 1966.

• **Team takes form**—The upcoming award will virtually complete the *Apollo* contractor team, although other spacecraft contracts will be awarded to industry over the next couple of years.

Only last week, NASA announced that General Electric has been selected to perform systems integration and checkout work required in mating the spacecraft to its launch vehicle.

Earlier, North American Aviation, Inc., was selected as prime contractor for the spacecraft, with its major role the development of the command and service modules and systems integration for the whole spacecraft.

MIT has been selected to develop the guidance and navigation systems for the spacecraft.

The list of other contracts which will be awarded later in the *Apollo* program includes:

World-wide tracking network—It is certain that the *Apollo* program will require additional tracking facilities beyond the current *Mercury* and Deep Space Instrumentation Facility networks. Intense study is now being put into the problem by NASA, but no decision has been made as to additional requirements. It is certain that the Goddard Space Flight Center will have prime responsibility for its development, but industrial contracts will be awarded.

Orbiting Laboratory Module—Its development is dormant at the present time, and no contract will be awarded for at least another year. NASA emphasizes that it is certain the module will be included in the program at some future time, but the date will depend on what space environment problems develop for the pilots.

Mission Control Center—This will be built at Cape Canaveral. It will be the central control point for all aspects of the preflight preparations and flight missions of the spacecraft.

Guidance—One or more industrial contractors will be selected shortly to work with MIT on the guidance system (M/R, Feb. 12, p. 34).

• **Engine puzzle**—NASA officials expect to invite all qualified airframe manufacturers to submit proposals on the lunar-landing module. One of the big problems for the firms will be to decide what engine or engines will be used.

The requirement for a liquid hydrogen propulsion system narrows the choice down to only two existing engines —Pratt and Whitney's RL-10 with 15,000 lbs. trust and Rocketdyne's J-2 engine with 200,000 lbs. thrust.

Although the latter is more powerful than the thrust required, NASA officials are not ruling it out.

Similar engines are on the drawing boards of other missile space firms, and it is possible that one of these may be selected.

Prime mission of the module is the soft landing on the moon. It will require a restart capability in order to go into lunar orbit and it will need some sort of thrust-vectoring to control attitude.

It must also have high specific impulse, which means that liquid hydrogen must be used as the propellant.

The GE contract which was announced recently will be worth only $1 million for the first six months, but its value will be many times that over the course of the *Apollo* program.

In the first six months, the firm will study what is required to develop a system for integration and checkout of spacecraft and launch vehicle.

Later it will be responsible for:

—Assuming overall responsibility for the reliability of the spacecraft and launch vehicle.

—Doing systems integration and checkout.

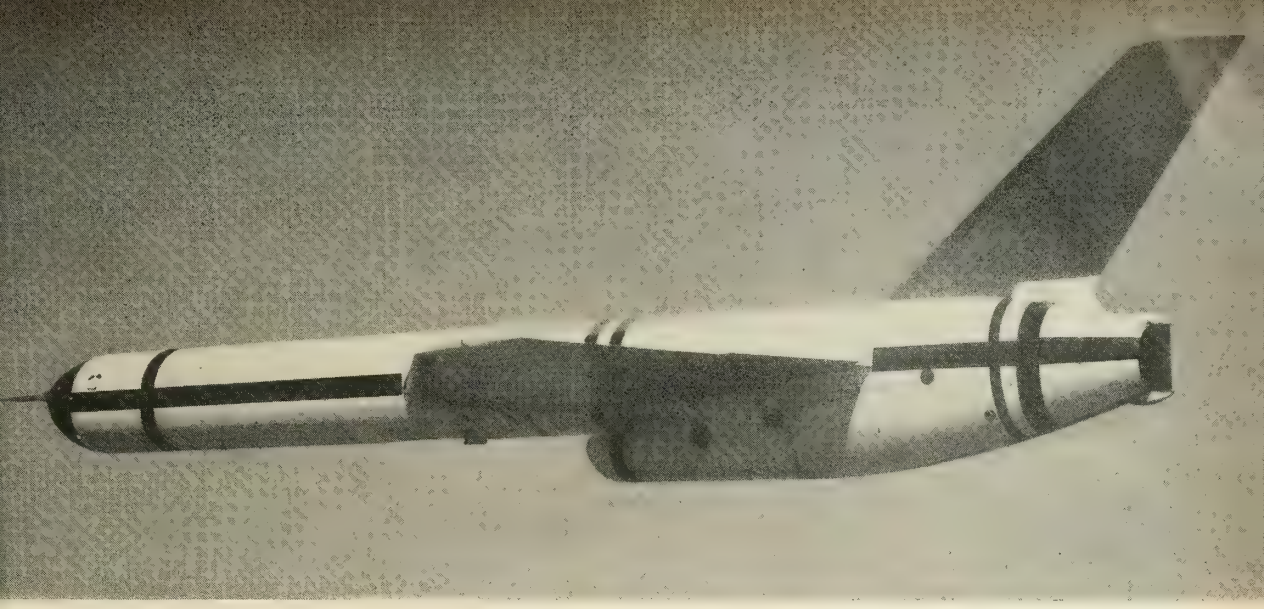
—GE will fill the gap between North American, which will do the space craft integration, and NASA's Office of Manned Space Flight, which will do the systems integration for the whole *Apollo* program—which includes tracking and astronaut training. ■

Lockheed Wins Apollo Escape Motor Award

LOCKHEED Propulsion Co. has been selected to design and build a solid-propellant launch escape motor for the Apollo spacecraft.

The subcontract was awarded by the Space and Information Systems Division of North American Aviation, Inc., principal contractor for the Apollo program, which said it will be worth an estimated $5,000,000.

Lockheed Propulsion (formerly Grand Central Rocket Co.), a subsidiary of Lockheed Aircraft Corp., built the escape motor for the Mercury spacecraft. In the Apollo program, the device will separate the manned command module from the rocket booster in the event of an emergency during the launch or prelaunch phases.



SD-5 returns to predetermined area after mission and dumps remaining fuel before recovery.

$75-million outlay . . .

SD-5 May Decide Fate of Drones

Fairchild's sophisticated bird could have many uses; support needs simplifying

by Charles D. LaFond

YUMA TEST RANGE, ARIZ.—The future of long-range high-performance military drones may rest with the *AN/USD-5* Surveillance Drone now in final development.

After nearly 5 years' effort and over $75 million investment by the Army, even the staunchest drone advocates believe that engineering model tests over the next few months must show a success. Otherwise, they see the end of a requirement for such a vehicle for at least the next 5-10 years.

The *SD-5* program got a boost last week when the drone successfully completed a high-altitude, long-range R&D flight under control of its Inertial Navigation System. Another recent attempt to test the INS system had been scrubbed just before launch due to guidance troubles. Earlier short-duration INS flights were completely successful, according to Walt Schafer, Fairchild Director of Engineering.

Prime contractor for the program is Fairchild Stratos Corp. Command and control electronic subsystems are being developed by the company's Electronic Systems Division, at Wyandanch, L.I., N.Y.; airframe, launcher, other ground support, and systems integration is being carried out by the Aircraft-Missiles Division at Hagerstown, Md.

The Signal Corps contract is being performed under the supervision of the Army Combat Surveillance Agency with technical direction by the Signal Research and Development Lab at Fort Monmouth, N.J.

Scheduled now to be operational in late 1963, the turbojet-powered unmanned aircraft is designed for the primary mission of supporting tactical *Pershing*-class missile systems.

Reportedly capable of flying distances exceeding 2000 miles at altitudes of from a few hundred feet to over 35,000 ft., the highly sophisticated drone obviously could perform many other military or even non-military functions.

Under flight-testing since mid-1960, the *SD-5* so far has had 13 successful flights, 2 partials and 4 failures.

Success of current test flights will go a long way in proving the polygamic marriage of the guidance and control system, terrain avoidance radar and the electronic recovery subsystems.

Success also may add impetus to a program that has slipped at least six months behind schedule.

• **Multi-sensor package**—One-third of the *SD-5's* 36-ft. length is designed to carry surveillance equipment. The nose of the airframe carries the TARA, or Terrain Avoidance Radar, built by Texas Instruments, Inc.

Also included in the forward section is a KA-30 or T-11 reconnaissance camera, an infrared sensor system (AN/AUS-5) and SLAR, side-looking radar. Both SLAR and the IR equipment were also developed by Texas Instruments. Other subsystems which might be carried include radiological detection and measuring devices, chaff dispensers, meteorological instruments, and in-flight film processing equipment.

A UHF data link for line-of-sight communication between the drone and ground are provided, as well as a reverse data link, which employs a transponder, for beyond line-of-sight transmissions from ground control.

The remaining length of the bird contains a highly sophisticated Inertial Navigation System (INS), Flight Control Unit (FCU), CAT (Command and Triangulation system), cooling system, hydraulic-driven alternator and auxiliary electrical power, and the propulsion system.

To lift the 4.5-ton vehicle from its zero-length launcher, a 4000-lb.-thrust solid-propellant booster is used. Devel-

SHORTLY AFTER LAUNCH, 4000-lb.-thrust solid booster drops off. J60 3000-lb.-thrust engine then supplies power.

MOMENT OF TRUTH—Just before touchdown, vertical swing is negligible. Impact on all three bags occurs simultaneously.

oped by Picatinney Arsenal the booster is dropped from the air-frame shortly after launch.

About the end of the booster nozzle is a jetavator which permits ±5° vector control in the pitch axis.

Principal power is derived from a J60 Pratt & Whitney 3000-lb.-thrust turbo-jet engine. (It is worthy of note that the auxiliary-power alternator energized with ground power is used as the engine starting motor.)

Fuel for the big engine is carried in each Fiberglas-honeycomb wing. The outer skin of the wings is also fabricated from Fiberglas.

The drone fuselage presently is of aluminum. However, Fairchild is now studying other materials including Fiberglas for the outer skin.

• **Guidance and control**—Heart of the guidance system for the *SD-5* is the INS. It consists of a three-gyro stabilized platform, developed by Minneapolis-Honeywell, and a digital processor and programer, developed by Hughes Aircraft. A drum-type memory unit is employed for programing complete flights.

All test vehicles are provided with a radio command backup to assure ground or chase-plane control if necessary.

TARA, with its altitude determining radar and computer subsystem, supports the INS. In the "hug" mode, it provides clearance-over-terrain data to the INS. For other missions, it provides override commands to the Flight Control Unit for obstacle clearance.

Besides its navigational function from launch to return to recovery area, the INS programer directs all the sensory subsystems over appropriate target zones. Flight paths over targets may be anything from a single pass over a specific area to a sweep pattern covering a whole zone.

Electronic outputs from the various sensors may be directed through the INS to a Flight Data Processor. From the processor, data can be presented in a cathode-ray tube and photographed for storage, and/or they can be transmitted via the uhf data link to ground stations for readout and storage.

Upon return to the recovery area, the master control station acquires flight control of the drone with CAT, the Command and Triangulation system. Essentially a short-range radio command and locating system, it employs a uhf slave receiving station and an Army BasicPac Mobile Computer (built by Philco) to bring the bird into a relatively small drop zone and to initiate the recovery system.

• **Recovery and reuse**—Fairchild's recovery system is elegantly simple, but remarkably effective. Engineers here at the Drone Test Range said that to date no failures have been attributed to this system.

Just before initiating the recovery system, all remaining fuel is dumped from outlets on the wing tips. Contained in the fuselage on the topside of the drone are two 78-ft. parachutes. Upon release, they are each pulled rearward on either side of the rudder by a small pilot chute and a larger drogue chute. The mainchute lines are restrained until the chutes are evenly filled and fully elongated. The restrainer is then cut automatically and the twin chutes open fully.

At the same time three double concentric pneumatic bags are released and inflated: one protruding downward from beneath the drone nose and one bulging below each wing. Each bag contains a smaller inflated bag.

On impact with the ground, blowout patches in each of the outer landing bags release air and thus cushion and help stabilize the vehicle. The inner bags remain intact, keeping the vehicle at a safe height above ground.

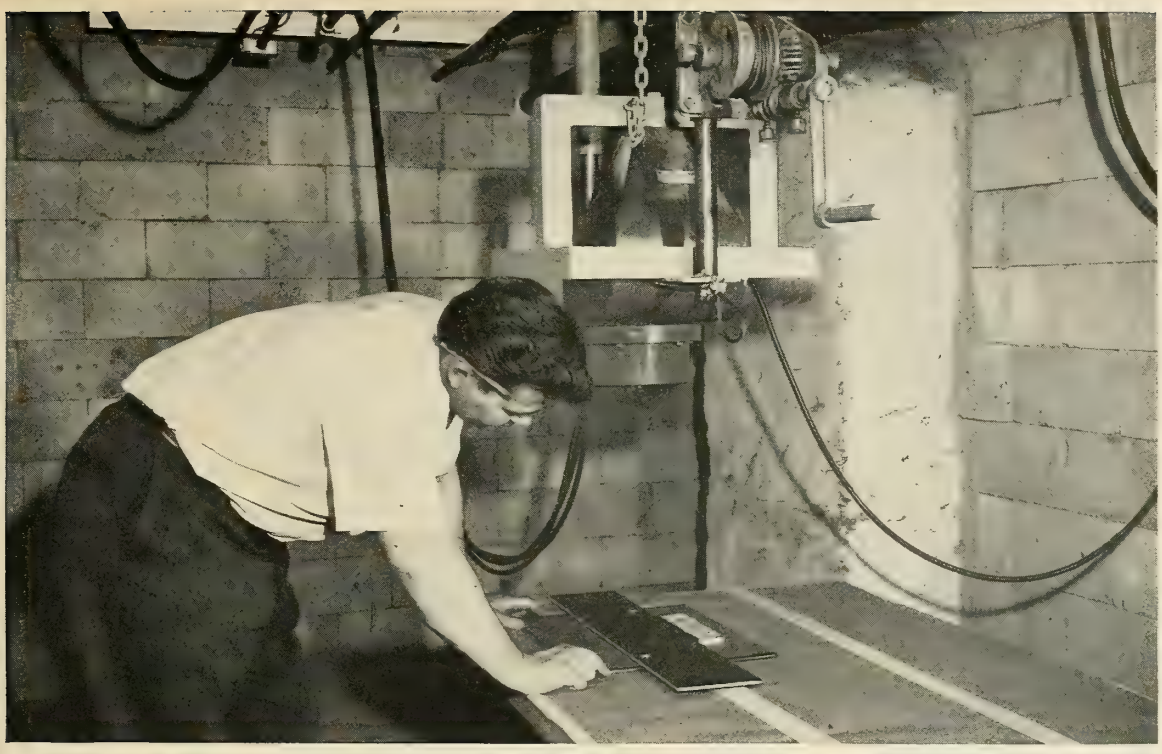
After a short delay (roughly 20 sec.) an impact switch releases the parachute assembly.

With relatively simple maintenance and repacking, refueling, and checkout the drone should be ready for its next mission.

• **What next?**—R&D tests of the all-weather drone will continue for some time yet. The next major step in the program is to study and determine operational requirements for the system.

Another aspect bound to receive more study are various applications for these drones. A drone of this type offers an inherent capability for dispersal of chemical and biological agents, dispensing of bomblets, and delivery of high-priority cargo—as well as other applications already alluded to, such as surveillance and photogrammetry.

Much work remains to be done in minimizing requirements for the launch and flight control complex maintenance and checkout systems needed to support the *SD-5*. Overcomplication on the ground could negate all the designed flexibility of the bird. The overall system must be as mobile and must react just as fast as the Army units whom it may someday assist. ⌘



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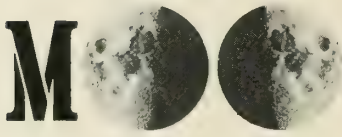

About fifty-billion dollars will be spent in the next decade to develop the moon program—80% with industry.

NOVEMBER 27, 1961 — MISSILES AND ROCKETS published its NASA Issue, an in-depth study of the National Aeronautics and Space Administration's programs, projects, facilities, personnel, and contracting procedures—emphasis centered on NASA's future material and contract requirements. JANUARY 5, 1962 — Over 1,000 single copies ordered by companies and individuals. JANUARY 11, 1962 —NASA purchased 60,000 reprints of the editorial section of the NASA issue.

NOW — MISSILES AND ROCKETS, for the first time, offers companies interested in doing business with NASA the opportunity to buy reprints of the editorial section of the NASA Issue—1961's most important and informative missile/space publication.

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Technical Countdown

ADVANCED MATERIALS

Electromagnetic Ballistic Gun Studied

Northrop's Norair Division scientists are developing an electromagnetic ballistic gun capable of firing small metallic projectiles at speeds of 100,000 fps—the velocities of meteorites in space. Electrical energy required for the accelerator might approach 1 million amps. Norair physicists admit that the technological problems, particularly in materials, are formidable.

Dynapak Successful at Bendix

The Utica Division of Bendix Corp. reports consistent success with a model 1210 General Dynamics Dynapak. The unit has a working stroke of 12 in. and a cylinder diameter of 12 in. The $60,000 machine paid for itself in less than a year. Utica has forged titanium, Udimet 500 and Hastelloy C.

Domestic Beryllium Flake Source Revealed

The Beryllium Corp. produces high-purity beryllium flake at its Reading, Pa., plant. Increased interest in the electrolytic flake form for experimental use prompted the firm to establish the facility, which may be expanded depending upon the results of evaluations by companies engaged in beryllium programs.

Portable Electron Beam Welder Developed

A set of unique sliding seals which hold the necessary vacuum in electron-beam welding permit North American Aviation researchers to move an electron gun along a track. The part being welded forms one wall of the vacuum chamber. The current unit is limited to 2-ft. welds, but a production machine being planned will handle welds from 5 to 8 ft. long with a single chamber setting. The development might lead to a large scale production use of electron beam welders, since the vacuum work-area is the limiting factor.

150-Ton Ring Rolling Mill Operational

Standard Steel Division of Baldwin-Lima-Hamilton has extended its high- and superalloy ring rolling capability with the installation of a new 150-ton ring rolling mill. Greater flexibility and closer dimensional control are possible because of automatic diameter indication and control. The unit has a 200-HP variable-speed main roll drive motor and a 75-hp hydraulic power unit for the pressure cylinder.

ELECTRONICS

High-Power Shock Tube Ready

Interaction of extremely high-power microwaves with plasmas generated in a high-Mach shock tube will be studied at the Polytechnic Institute of Brooklyn's Long Island Graduate Center. The Center recently put into operation a high-power amplifier capable of a 100-megawatt output. Built by Sperry's Electronic Tube Division at a cost of $2.2 million, the equipment will deliver 10 megawatts of peak power in short pulses at a frequency of approximately 5500 mc. to reach a 100-megawatt peak, the device is coupled to a circular 500-ft. microwave flywheel tube.

Radar/Inertia Elements Wedded

Sperry Gyroscope is proposing a new 90-lb. navigation system for return and recovery of space vehicles. Called LASSO (Landing and Approach System—Spiral Oriented), it is described as being 10 times faster than comparable systems in advising the astronaut of his position and course. Initiated at 20,000 miles from target area, inputs from conventional optical/inertial instrumentation are collected. At 5000 miles altitude, a Sperry inertial radar altimeter would be employed to supply precise navigational data including relative velocity and altitude. System accuracy even at hundreds of miles is within a few hundred feet, the company says.

Amplifier Tube Efficiency Increased

Traveling-wave amplifiers—developed for use in radar and satellite communications—can be made 40-100% more efficient, two University of Michigan electrical engineers report. The theory and method, devised by Prof. J. E. Rowe and graduate student John Meeker, involves slowing down the signal wave on the tube helix. By varying the number of turns or coils per inch of the helix near its end, the energy level within the tube can be controlled. By increasing the number of turns, the signal remains more in phase with the electron beam—with a consequent increase in efficiency.

ASTRONAUTICS

Geomagnetism Study Outlined

During the World Magnetic Survey—scheduled from 1963 through 1965—several scientific satellites will be launched into polar orbit to supplement the existing mapping data on the earth's magnetic field. Dr. J. P. Heppner of the Goddard Space Flight Center discussed the plan before a Voice of America audience recently. He stressed that knowledge of the location of regions in space where the strength and direction of the field are most disturbed is essential in determining the origin of various magnetic field variations.

SUPPORT EQUIPMENT

Lockheed Opens Antenna Lab

Lockheed-Georgia Co. is putting the finishing touches on a 10,000-sq.-ft. research and development center for aerospace and aviation antenna studies. The air-conditioned lab, the company says, includes humidistats for constant temperature and humidity controls, a microwave darkroom for measurements above 940 mc. and special apertures in the roof and walls for antenna testing.

Army Announces Space Office

A new Space Construction Office has been established in the Office of the Chief of Engineers to coordinate all Army Engineer activities carried out for NASA. Head of the new organization will be Col. Thomas J. Hayes III—current Commander of the Corps of Engineers Ballistic Missile Construction Office in Los Angeles—who has been nominated for promotion to Brigadier General. Col. Hayes will assume his new duties about March 1.

Launch Date Nears for First Telstar

AT&T's space communications satellite will test system feasibility, carry important radiation package

by Michael Getler

NEW YORK— Anyone close enough to look inside AT&T's *Telstar* communications satellite will find 2325 semiconductors, 1301 diodes, 1024 transistors, and one traveling wave tube.

Details on how the lonely TWT and the more numerous miniatures fit into the satellite's technical makeup began unfolding here this week.

In May, *Telstar* is slated to ride a *Delta* boost vehicle from Cape Canaveral into an orbit ranging from 500 to 3000 miles.

Four flight versions of *Telstar* and four test models which closely resemble the actual flight configuration are now in final stages of fabrication and test at several Bell Telephone Laboratory facilities.

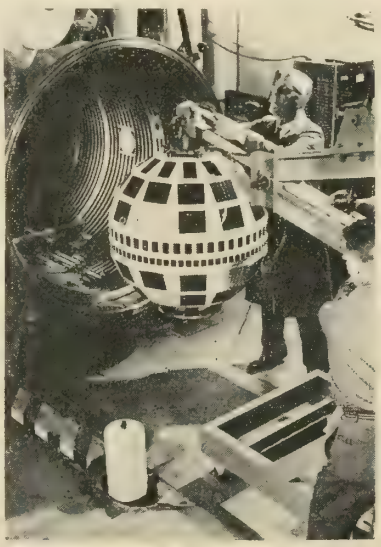
Three to four weeks prior to scheduled launch, two flight satellites—one to go and the other as backup—will be moved to the Cape. In the event of an unsuccessful first shot, the backup would be launched in about two months.

The current contract between American Telephone & Telegraph Co. and the National Aeronautics and Space Administration calls for NASA launch and track of two experimental versions of *Telstar*, with provision for backup launchings if needed. Cost to AT&T for each NASA-controlled launch and track operation is approximately $3 million.

The extensive net of Bell ground support equipment—including a huge 300-ton 177-ft. long T/R horn antenna and tracking and control equipment at Andover, Me., beacon and telecommunications reception gear at Holmdel, N.J., and a track and test facility at Cape Canaveral—is scheduled to be operational within the next six to seven weeks.

• **Close to Relay shot**—The planned *Telstar* launch schedule coincides closely with launch plans for NASA's *Project Relay* communications satellite, in which Bell will also participate in transmission experiments. The first *Relay* flight is expected by mid-year. NASA is installing a special transmitter for *Relay* at Bell's Andover site. Receiving equipment will be the same as for *Telstar*.

Experimental versions of *Telstar* are designed primarily to test the practicability of broadband communications via satellite. The role of the initial vehicle will be to receive a 6390 mc radio signal from the Andover transmitter, amplify the signal roughly ten billion times within the satellite's communications package, and retransmit the signal on 4170 mc to Bell receiving equipment at Andover, Holmdel, and several other widespread governmental and commercial listening posts. International telephone and television experiments will probably get a trial run with *Telstar* later this year as European stations become operational.



BELL TECHNICIANS prepare to give space-simulation test to Telstar. Thermal model is being put into thermal-vacuum chamber (left), whose walls are cooled to simulate heat absorption in space.

In addition to *Telstar's* basic communications mission, the satellite will also carry aloft what could be a highly significant radiation package. The experiments include a thorough probe of inner Van Allen belt electron energies and densities, and studies of radiation effects on various semiconductor devices vital to active space communications.

Here is the latest breakdown on the satellite, its major systems, and the radiation experiments:

Airframe—The *Telstar* shell, measuring 34½ in. in dia., is of aluminum, with magnesium used for the framework. The shape is roughly spherical, with 72 flat facets positioned around the shell for mounting 3600 solar cells and a single reflective mirror (to assist ground observers in visual sightings). Total weight including the communications package is 170 lbs.

Antennas — The two major T/R communications antennas girdle the satellite about its mid-section. Antenna efficiency, Bell reports, is nearly equal in all directions—with the exception of the satellite's pole regions, where nulls do exist. The satellite is spin-stabilized during launch to avoid having the antenna null positions directed towards the earth when the satellite is over the northern hemisphere. These major antennas will also transmit a precision tracking beacon.

After the satellite achieves orbit, a third antenna will be extended from inside *Telstar* after a protective fairing has been jettisoned. Telemetry, command, and beacon circuits will be served by this antenna.

Two small whip antennas at the base of the satellite will handle telemetering requirements during launch.

Power Supply—Power for the electronics will be directly supplied by 20 rechargeable nickel-cadmium cells. The 3600 solar cells which dot the skin of the satellite will provide the charge for the nickel-cadmium cells. Initial solar-cell conversion output is expected to be 15 watts. Due to anticipated radiation and meteroid damage, this figure will probably drop to about 11½ watts after about a year in orbit.

The solar cells will be mounted on a ceramic base with a platinum frame, and will be shielded from electron bombardment by a clear, laboratory sapphire material.

Electronic Chassis—Bell has taken considerable care to insure that chassis design will provide sufficient shock and vibration attenuation.

The electronics will be sealed in a 20-in. aluminum canister suspended within the airframe by nylon cord lacings.

Polyurethane, a plastic foam which becomes rigid when it sets, will be poured and molded around each electronic subassembly. When these units have all been assembled within the canister, the chemical will be poured into the entire canister to form a completely rigid structure.

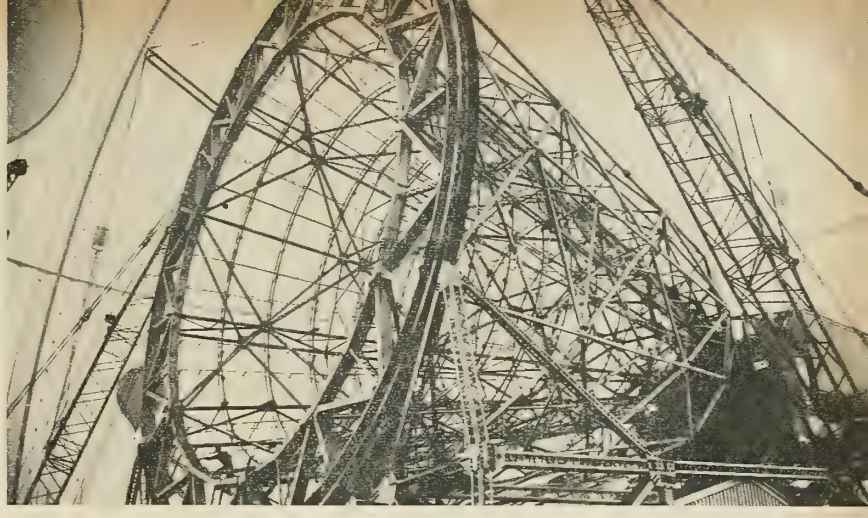
This technique was used by Bell during missile guidance-system development for the *Titan II* ICBM.

The sealed cask will be partially evacuated of air and filled with a gas at slightly below atmospheric pressure. Temperature within the chassis will be regulated by a thermally controlled lid at the top of the unit.

Comm Circuit—*Telstar's* incoming 6390 mc signal is first mixed with a quartz crystal-controlled beat oscillator frequency to produce an IF signal centered at 90 mc (a frequency low enough to be within range of reliable transistors). During normal operations, the 90 mc signal is then amplified about one million times by 14 diffused-based germanium transistors. Total amplification is controlled by an automatic gain control device to insure constant output regardless of incoming signal strength and slight component decay.

A second crystal-controlled oscillator frequency is then mixed with the 90 mc signal to produce a frequency centered at 4170 mc for retransmission to earth stations. A final amplification is accomplished before the signal is actually retransmitted by the single electron tube installed in *Telstar*.

Bell engineers say this foot-long, thin-glass traveling wave tube "is the only device in the world capable of amplifying such a broadband signal 5000 times."



HUGE SKELETON forms in construction of horn-shaped antenna for Telstar at Bell's Andover, Maine, facility. A 70-ft. wheel will rotate to point the antenna.

A tube very similar to the one employed aboard *Telstar* has already been used operationally aboard *Nike-Zeus* test missiles.

The TWT will also amplify a 4080 mc precision tracking beacon signal transmitted at about 1/200 watt.

Telemetry—Telemetry information in the form of coded pulses will be obtained from 115 different points within and around the satellite, including the communications equipment, the basic vehicle, and the radiation experiments. Each measured item is sent once per minute.

The coded pulses serve to frequency-modulate a 3-kc, ±225 cps, frequency. The resulting signal is used to amplitude-modulate the basic 136-mc carrier. This method allows use of the constantly radiating center frequency as an additional radio beacon for tracking purposes.

The special telemetering transmitter radiates ¼-watt power.

Command — In order to conserve power aboard experimental versions of *Telstar* for periods when transmission is desirable, a command system is installed to provide on/off control over the satellite's principal communications function as well as telemetry information.

The system includes a pair of receivers to handle pulse-coded 120-mc commands from the ground, a pair of decoders, a switch control net, and nine relays. The duplication in receivers and decoders is to insure command functions in the event either device fails. Should the 4170-mc communications frequency and the 4080-mc tracking beacon fail to respond to command control, the satellite's power supply would be drained within a few hours.

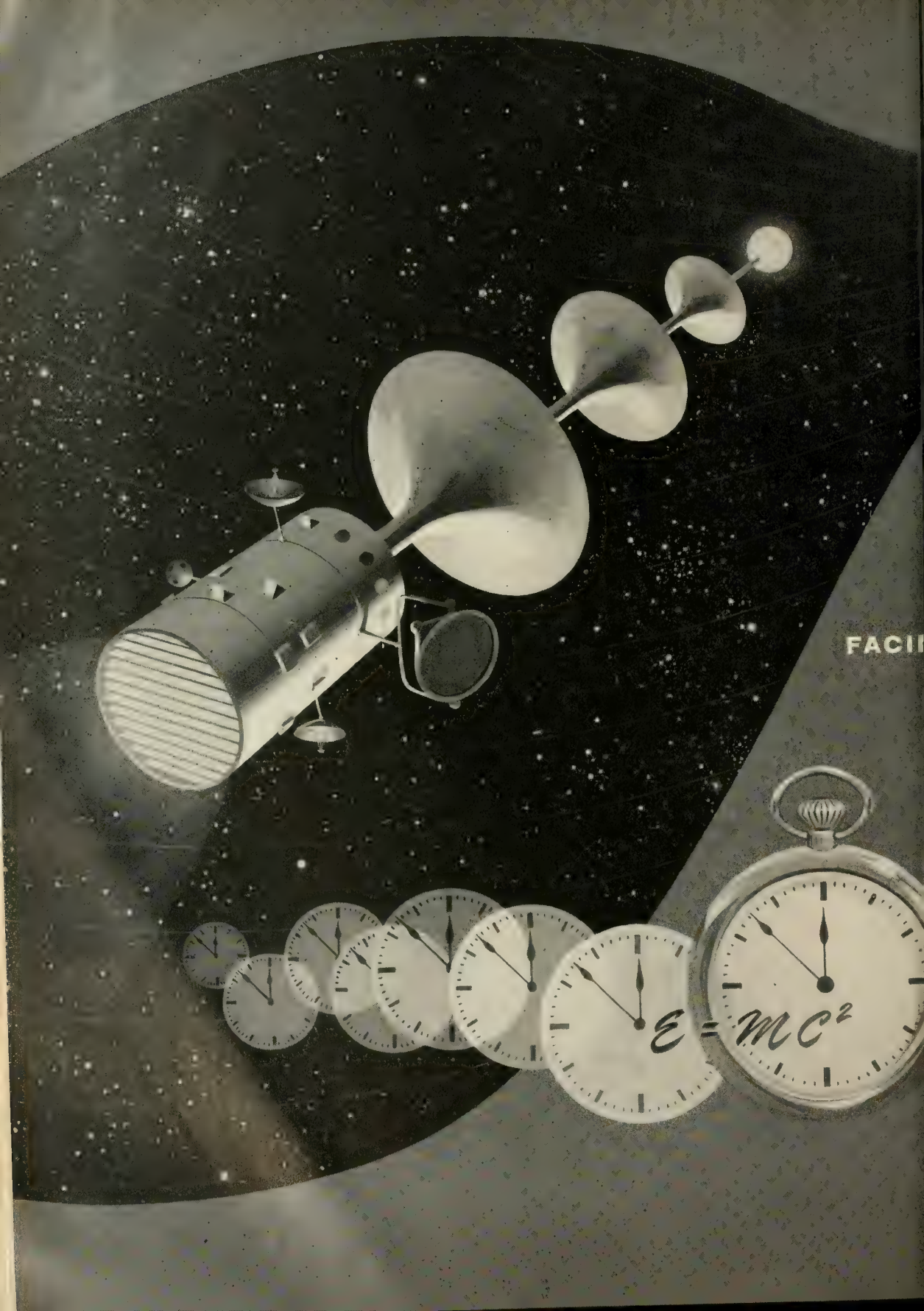
The command and telemetry equipment aboard *Telstar* account for a major portion of the vehicle's weight and complexity, using about 94% of the semiconductor devices employed.

Radiation Experiments — That portion of the radiation package aimed at measurement of electron energies and densities in space will be accomplished by four special Bell silicon-diodes located at the satellite's skin. Three diodes will count and measure proton energy, and one will be used for electron measurements (the electrical response of each diode is directly proportional to the particle energy loss upon striking or passing through the diode).

The amount of shielding for each diode varies according to the measurement role assigned. The thickest shielding is employed on the diode which measures proton energies above 40 Mev. Next is the device which measures proton energies above 25 Mev. The other proton device has even less shielding and has a varying bias to measure protons in each of five energy regions between 2 and 25 Mev. Shielding is also slight for the fixed-bias diode, which measures electron density and energy from ¼ to 1 Mev.

The second radiation experiment to measure actual damage to semiconductors, is performed by solar cells and transistors. Three solar cells, previously undamaged by radiation, will be monitored to learn the decrease in their short-circuit current output over a period of time. Each cell will have a different amount of shielding.

Also, six silicon-transistors—specially fabricated with a wide "base" region to increase sensitivity to radiation damage—will be mounted at the satellite skin in pairs, each pair shielded by a different amount. Their output will be monitored and compared over a period of time with the output of a seventh transistor, similar to the others except that it has been preradiated. ⁂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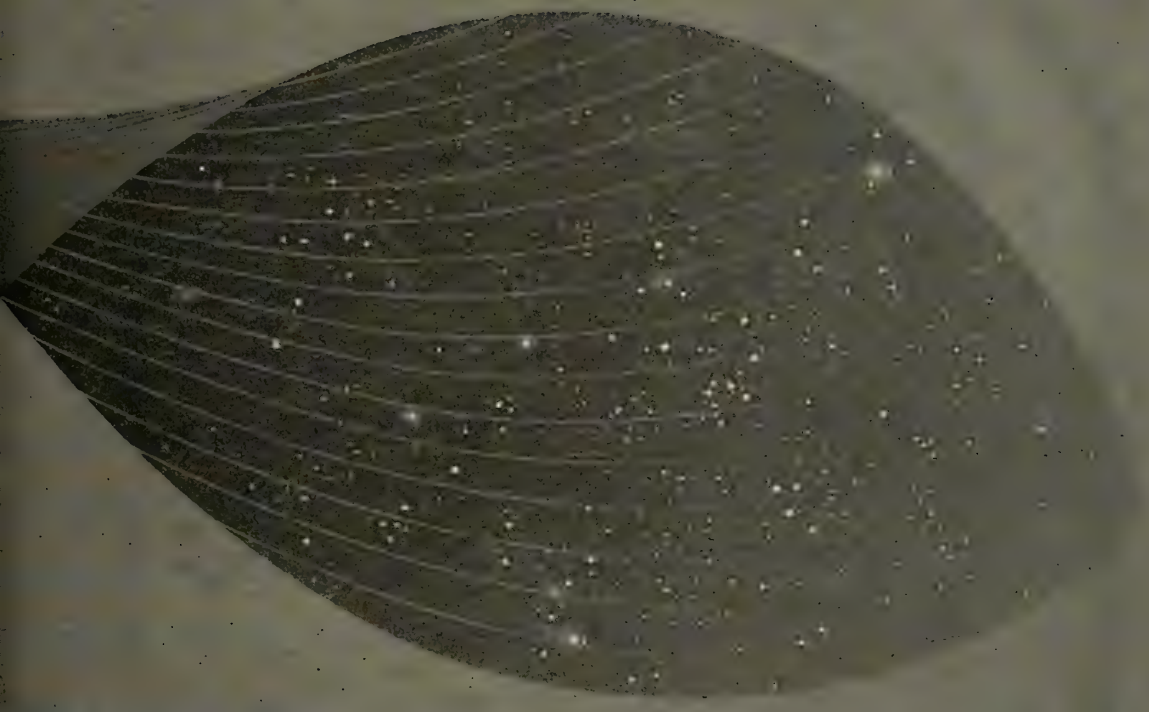
$E = mc^2$



HE FOURTH DIMENSION IN PROPULSION DEVELOPMENT

Whether the universe has a "saddle shape," or any shape at all, is a matter of interesting conjecture. The matter of space travel, however, is the subject of intense experimentation. A nuclear/thermionic/ionic propulsion system, currently being studied at Lockheed Missiles & Space Company, might well become the power source for space vehicles.

Its design incorporates a nuclear reactor only one foot in diameter, generating heat at a temperature of 1850°K. This is transmitted to banks of thermionic generators, converting the heat directly into electrical energy for the ion beam motor which uses cesium vapor as a fuel. The entire system is designed without any moving parts, minimizing the possibility of failure.

Lockheed's investigation of propulsion covers a number of potential systems. They include: plasma, ionic, nuclear, unique concepts in chemical systems involving high-energy solid and liquid propellents, combined solid-liquid chemical systems. The fundamentals of magnetohydrodynamics, as they might eventually apply to propulsion systems, are also being examined. Just as thoroughly, Lockheed probes all missile and space disciplines in depth. The extensive facilities of the research and development laboratories—together with the opportunity of working with men who are acknowledged leaders in their fields—make association with Lockheed truly rewarding and satisfying.

Lockheed Missiles and Space Company in Sunnyvale and Palo Alto, on the beautiful San Francisco Peninsula, is an exciting and challenging place to work. For further information, write Research and Development Staff, Department M-24F, 599 North Mathilda Avenue, Sunnyvale, California. An Equal Opportunity Employer.

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SSR Detectors Are Small, Sensitive

by Arthur H. Collins

LOS ANGELES—Tiny nuclear radiation detectors are providing answers to some vital questions concerning space radiation.

The semiconducting detectors also may find application in satellite systems for detection of nuclear explosions in space (M/R, Oct. 23, 1961, p. 12), or as monitoring devices for overall atomic research and reactor development.

Developed by Solid State Radiation, Inc., the devices' first satellite use was for proton detection on *Injun*, launched piggyback with *Transit IV-A* in June, 1961. They were also used in the *TRAAC* satellite carried piggyback with *Transit IV-B* in November, 1961, for detection of neutrons, protons, and particles heavier than protons.

Essentially solid-state ionization chambers with multi-microsecond responses, the devices are applicable to the detection of electrons, protons, neutrons, alphas, heavy ions and fission fragments. With the proper selection of coating materials, they may be used for detection of either fast or slow neutrons.

In general, the semiconductor detectors are smaller, more rugged, faster-responding and more sensitive than conventional detector systems. In contrast, current methods of detection relying upon gas ionization chambers and using electron multiplier tubes are large and heavy, and require glass envelopes for gas containment. They also need high-voltage power supplies that add additional weight to the payload. In this type of detector even the glass envelope inhibits some of the particles that are detected by the solid-state semiconductor detectors. These earlier detectors found use on *Explorer VII* and *Ranger II*, and were aboard the *Injun II* satellite which failed to go into orbit.

Upper limitations of energy resolution of the SSR detector are set by the combination of noise generated by the detector and the input amplifier stage. Typically, this is 50 kev for a transistor-type amplifier and 20 kev for a vacuum-tube amplifier. Since the quantity of charge generated within a semiconductor detector is 10 times greater than that generated within a gas ionization chamber, the resulting statistics are at least three times better for a measurement of energy.

The limit of linearity of pulse height vs. energy for particles of different mass is set by the range of the given type of particle in the semiconductor material as compared to the depth of the sensitive volume.

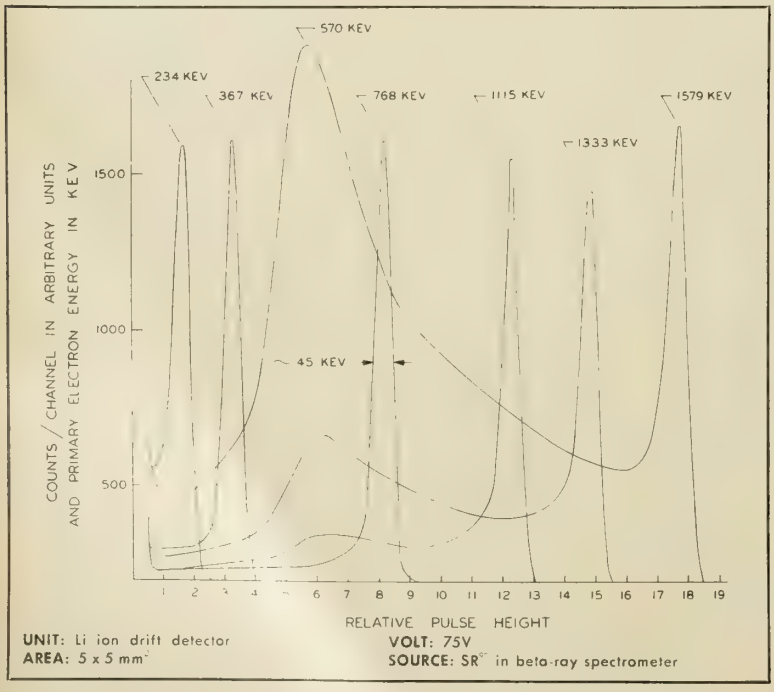
Detector size at the lower limit is set by the required area for wire contact to the two surfaces of the device and the requirements for support of the device and its leads. In this vein, SSR has recently found practical application for a detector with dimensions of 1 cu. mm which may be installed in a hypodermic needle for insertion in body cavities.

Neutron detection is readily accomplished by coating the semiconductor detector with a suitable neutron-to-charge particle-converter material such as B^{10}, U^{235}, U^{238}, Np^{239}, Li^{6} and Hydrogen. The neutron-proton reaction within the silicon itself is more than adequate for fast neutron detection.

Counting rates of nuclear particles in the 100-mc range are feasible because the rise time of the pulse of a nuclear semiconductor radiation is typically in the nanosecond range.

• **Few counts**—Because of the small volume, background counts due to cosmic radiation and container contaminants are minimal. Background counts from within the detector are essentially non-existent, because detector material purity is the highest known—impurities are measured in parts per billion. This makes the nuclear semiconductor detector particularly useful for low-level counting of electrons from P^{32}, C^{14} and others with similar characteristics.

One-dimensional arrays of the detectors can be used to replace the photographic plate now used in the focal plane of beta-ray and alpha-ray spectrometers. This would eliminate current



RESPONSE of lithium ion drift detector to beta particles up to 1.6 Mev. Peak shown at 570 Kev is due to beta particles that go through detector as minimum ionizing.

requirements to recover the package, since this type of data may be telemetered to the ground. Also, the spectrum as a function of vehicle position may be obtained and telemetered to the ground for instant evaluation.

The range of particle energy where pulse height is a linear function may be augmented by placing particle absorbers (generally aluminized mylar foil) in front of a detector array. This type of array has been flown in the *Transit IV-A* and *Transit IV-B* space probes for investigations of protons in the outer Van Allen belts.

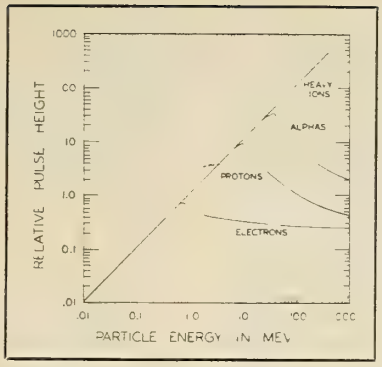
Two-dimensional arrays have been made to increase detection area. Detection area size is restricted, however, since the capacitance increases proportionately to the device's total area. Increasing capacitance area reduces the system's signal-to-noise ratio. Arrays of this type were used on the AEC's Project *Gnome* shot for neutron detection and on the *TRAAC* satellite with *Transit IV-B*.

A two-dimensional array may be used to form a beam profilometer and for analysis of the distribution and intensity of particles as they emerge from accelerators. Systems now in use at universities and experimental laboratories for beam-profile investigations require many months of machine operation for data evaluation. The new beam profilometer would, SSR says, provide the operator with an instantaneous profile of the beam following each burst of particles that passes through the array.

• **3-D potential probed** — Three-dimensional arrays are also under investigation at SSR. There probably would be many applications. The outputs could go directly to a computer for evaluation—eliminating the necessity of reading photographic plates presently used in such an application. Detector coordinates, triggered by passage of a high-energy nuclear particle, plus the pulse height from each detector, can be fed into a computer immediately. The computer will instantaneously compute the total energy and identify the particle.

In an alternate method now being investigated, the detector array can be replaced by a continuous slab of semiconductor material. Photo-resist techniques, similar to those used in photo-etched circuit cards, are employed for this detector fabrication. An array of this type would greatly reduce the number of amplifiers and power supplies required for operation of the discrete system.

The detector amplifier can be miniaturized to approximate the cross-sectional area of the semiconductor detector. When the cross-sectional areas of the detector and amplifier are the same, the units may be stacked to obtain larger area coverage.



RANGE of linearity of pulse height vs. energy for various nuclear particles.

A deeper depletion region is required to detect beta particles, gamma rays, higher-energy protons and alpha particles, and to obtain a more adequate signal-to-noise ratio for minimum ionizing particles. This may be achieved by an increase in resistivity of the silicon used within the detector, or an increase in the operating voltage. High-resistivity silicon is difficult to obtain because of the purification of the silicon during manufacturing. An increase in operating voltage is difficult due to surface and bulk breakdowns. In lieu of obtaining intrinsic silicon by greater care in the manufacturing process, it is possible to create effective resistivity by suitable dopant compensation.

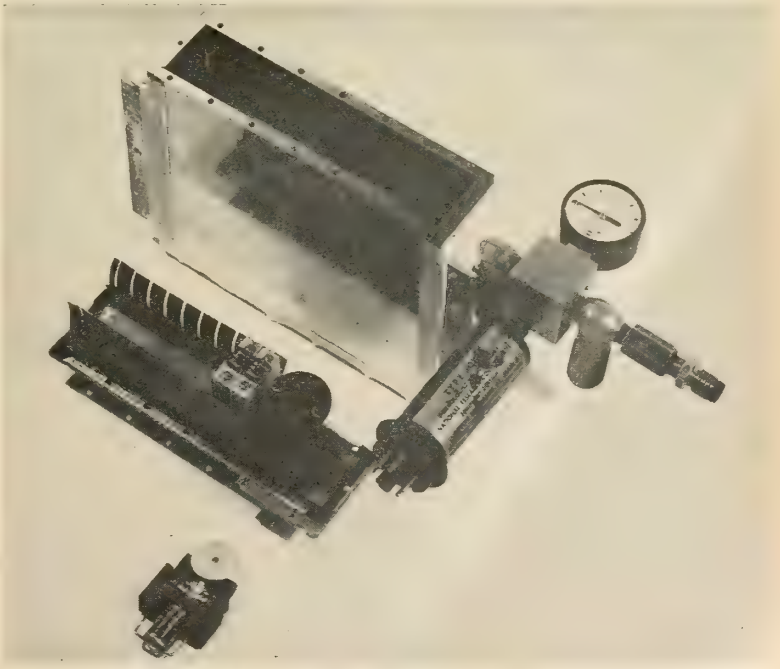
This compensation is accomplished when lithium ions are "drifted" into regions of P-type centers. Thus, if a N-P junction in silicon is formed and placed under reverse bias at an elevated temperature, the lithium ions will drift into the bulk of the P-type silicon, extensively compensating it. This results in a depletion volume that may be measured in millimeters instead of microns.

The response of such a lithium ion drift detector to beta particles is excellent. The device has a fairly good gamma-ray response but as yet is not adequate for gamma-ray spectroscopy. SSR had designed and is now testing an instrument using lithium ion drift detectors to monitor fast neutron bursts from low-level neutron generators.

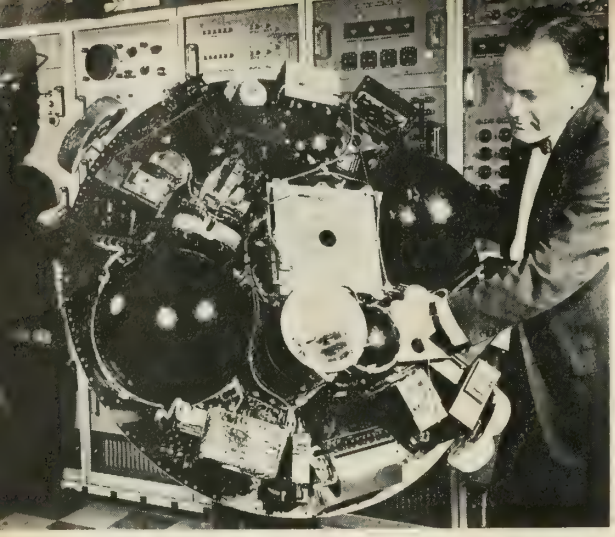
X-ray sensing detectors could be used on satellites for detecting nuclear explosions (M/R, Oct. 23, p. 12).

SSR president Dr. S. S. Friedland says: "The future of nuclear semiconductors lies in using higher-impedance materials for better response and in materials that allow operation at extreme temperatures. For each material, a mechanism equivalent to compensation of lithium in silicon must be sought."

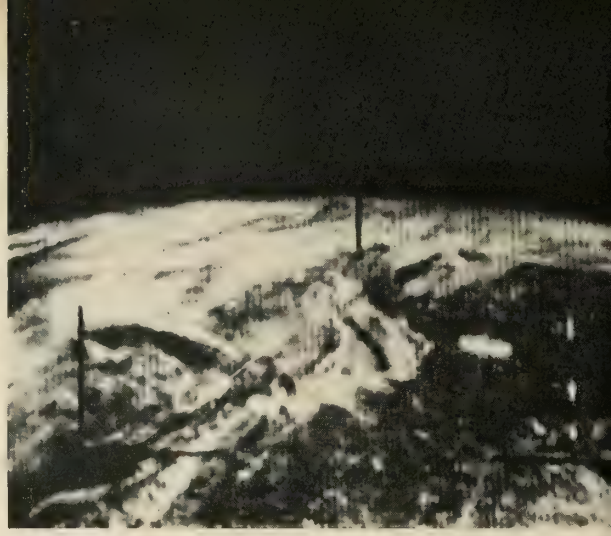
Transistor production techniques can be applied to detector fabrication, and SSR anticipates that within a year detectors will have a reliability comparable to that of transistors. ❖



ACTUAL PHOTOGRAPH of beta-ray spectrometer. A valve system was installed to keep the detectors under vacuum during the pre-launch period. Device utilizes a permanent magnet and a ten-element array of detectors in its focal plane for transmission of data and for dynamic measurements.



ENTIRE TIROS system is shown as Tiros IV gets final tests at RCA-Astro-Electronics. Ground equipment is in rear racks.



EARLY PHOTO from Tiros IV shows ice-free areas of Lake Michigan (bottom left corner) and Lake Superior.

space systems

NASA Plans Early Start on Aeros

NASA—gratified with the success of the *Tiros* series—is ready to begin development of its most sophisticated counterpart, the *Aeros* meteorological satellite.

Dr. William K. Widger, Jr., of the space agency's weather satellite office, said that ". . . architectural and design studies of *Aeros* will begin in the near future."

He added that funds for the program are included in NASA's Fiscal 1963 budget request. Actual fabrication of the satellite system, however, will not begin until the following year.

While no final decision has been made, the Goddard Space Flight Center probably will be the prime contractor for the 22,000-mile-high synchronous-orbit satellite system. Industrial contractors will be selected to build almost all of its components.

• **Excellent quality**—The early start on *Aeros* was disclosed shortly after the *Tiros IV* satellite, built by RCA, was successfully rocketed into orbit Feb. 8 atop a *Thor-Delta* booster launched from Cape Canaveral.

The Weather Bureau reported that the picture-taking satellite, in its first 24 hours aloft, had taken "striking pictures of excellent quality, of cloud cover, and of snow and ice distribution."

The satellite is circling the earth once every 100.39 minutes with an orbit inclined 48.29 degrees from the equator. Its distance from the earth ranges between 441 and 525 miles. Average velocity is 17,000 miles an hour.

A new lens is the biggest innovation in *Tiros IV*, compared to the three earlier satellites in the series.

One of the two TV cameras is fitted with a new, medium-angle Tegea Kinoptic lens, designed to take photographs with less distortion and covering an area of 450 miles on a side. Distortion is being corrected by meteorologists as they interpret the photographs. The removal of lens distortion, however, may allow the meteorologists to evaluate the pictures more rapidly. The second camera is equipped with a wide-angle lens, covering an area approximately 700 miles on a side.

• **Three steps** — *Tiros* and *Aeros* are actually the "end-men" of what NASA hopes will someday become an operational weather satellite system; in between is the *Nimbus* satellite.

The first launch of this more advanced system will follow three more *Tiros* orbitings spaced through the remainder of 1962.

Although scheduled for late this year, the first *Nimbus* launch will probably not take place until 1963. *Nimbus* will be placed in a polar orbit and will be oriented so that its cameras are always pointing toward the earth.

Goddard is the prime contractor for the system. Its research and development program calls for four launches. NASA officials expect, however, that several launches per year will follow on a continuing basis.

Following *Nimbus*—and perhaps even complementing it as part of a global weather reporting system—will come *Aeros*.

Although NASA is ready to begin development, the first launch in its R&D program is several years away.

Aeros will circle the equator at a distance of about 22,000 miles. In such an orbit, it will travel at the same speed that the earth rotates, so that it will seem to remain in a fixed position over a point on earth.

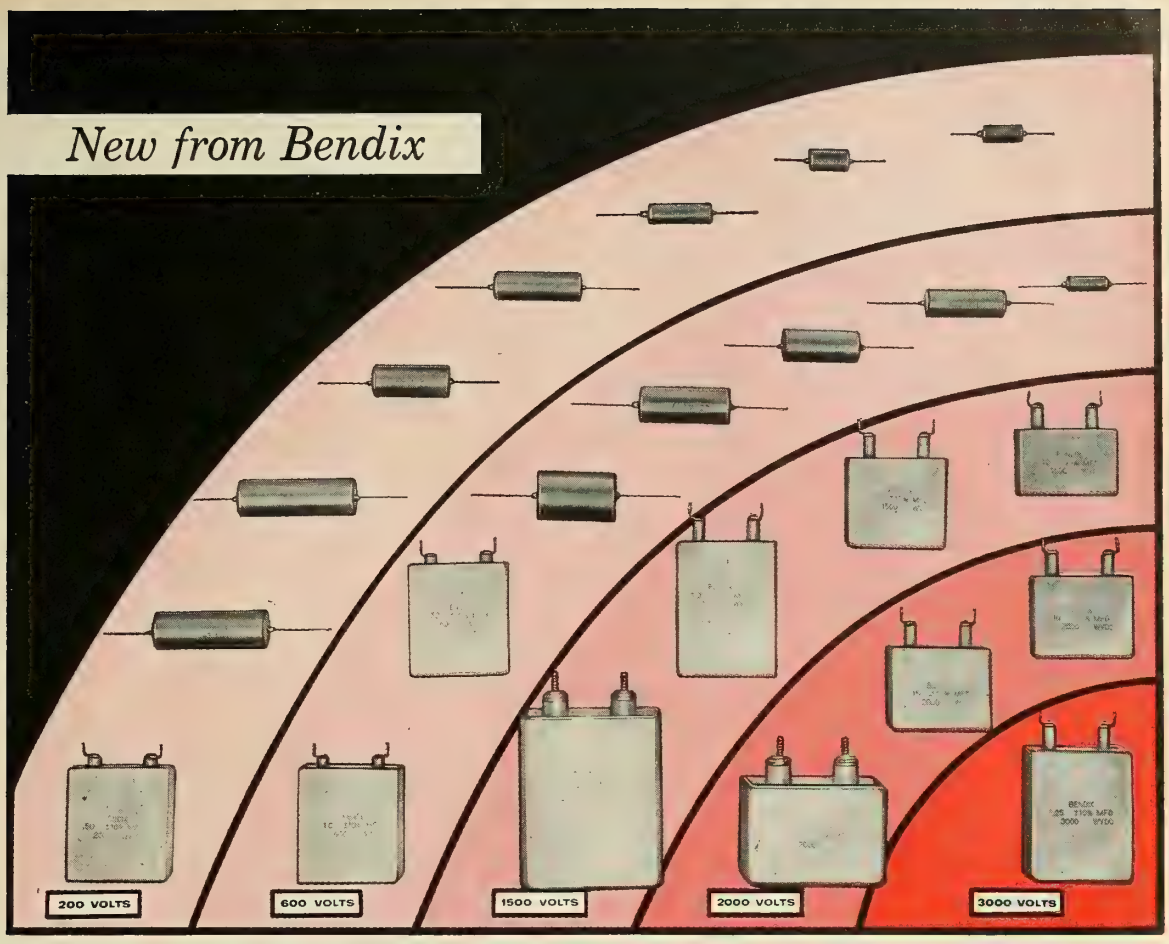
Looking even further ahead, NASA officials feel that ultimately a different type of spacecraft will be needed to maximize the system's usefulness.

• **Ice spotter**—For the present however, NASA and Weather Bureau officials are extremely pleased with the performance of *Tiros IV*.

They said that its success raised hopes that it may fulfill a new role—ice reconnaissance to aid navigation on waterways like the Great Lakes and the Gulf of St. Lawrence.

To decide the issue, a joint U.S.-Canadian scientific project has been set up. Shortly after the satellite blasted off from Cape Canaveral, 13 aircraft from both countries roared aloft to take photographs of ice distribution in the Gulf of St. Lawrence and is environs.

The plan is to compare the airplane photos with those taken by the television cameras of *Tiros IV* in the same areas and study the feasibility of using satellite photographs to map ice areas. ⁂



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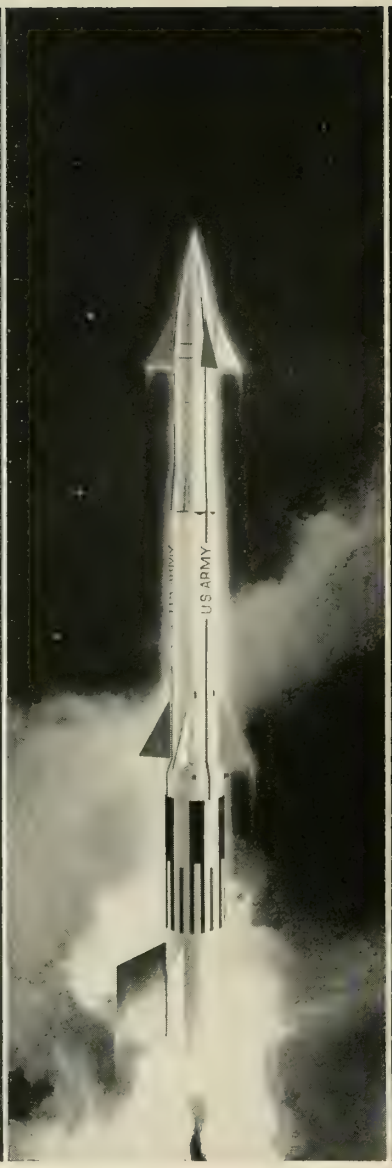

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Documentation Error Lost Ranger III Photos

Longstanding mistake in system design left spacecraft and operators talking different 'language' about new maneuver

by Bill Wilks

PASADENA, CALIF.—The *Ranger III* flight disclosed an elementary documentation error which resulted in the spacecraft receiving "reverse" orders for its midcourse maneuver.

"*Ranger III* performed its midcourse maneuvers perfectly, but just in the reverse directions because of a documentation error which had existed ever since the system was designed," Jet Propulsion Laboratory's Project Director James Burke told MISSILES AND ROCKETS. "There was a sign reversal between the maneuver computing program and the spacecraft mechanization. The spacecraft spoke a language in which zero was positive and one was negative. The other part of the system, the maneuver computing program, had just the reverse information. In other words the vehicle operated in one system of coordinates and the human operators in another."

Intention of the midcourse maneuver at that point—since it was known *Ranger III* was going to miss the moon—was to adjust the vehicle's transit time so it would move farther from the moon and thereby optimize the Goldstone Tracking Station's viewing conditions during the picture-taking phase of the mission. This would have placed it about 25,000 miles from the moon. To accomplish this, *Ranger III* was rolled 10 degrees about its longitudinal axis and then pitched 116 degrees away from the sun.

• **Contrariwise** — "It performed these maneuvers just as instructed," Burke said, "but the reverse instructions made it roll and pitch in just the opposite directions." Result was that the midcourse rocket motor fired in the wrong direction, moving *Ranger III* closer to the moon so that it passed at a distance of 22,862 miles. This meant the spacecraft passed the moon late in the Goldstone Tracking Station's viewing time, although it remained above the Goldstone horizon as well as that of the Woomera Tracking Station.

Earlier in the mission it was known that the 200-ft.-per-second excess speed caused by a component malfunction in the *Atlas* booster would cause *Ranger III* to pass ahead of the moon and enter a heliocentric orbit. However, it was decided to see what lunar pictures could be obtained anyway.

At this point an apparent electronic malfunction aboard the spacecraft spoiled the terminal phase of the mission. The error in sign convention had been corrected, and the vehicle followed orders, accomplishing its first pitch turn.

"But then we saw an extraneous blip on the readout," Burke said. "The vehicle began another unexpected, pitch turn, apparently because of a signal receiver from the central computer and sequencer aboard the craft. The earth-sensor lost its earth-lock, and ordered the craft to go into another roll search. During lunar flyby, the craft had not been reoriented and the pictures we received were all 'snow'."

• **Positive side** — Overall, Burke rates as one of the most significant achievements the successful operation of the earth-oriented, high-gain antenna. This was a "first" with *Ranger III*, since the earlier *Rangers* remained near the earth, "the results being that the earth presented too large a target for the antenna earth-sensor to "spot" and lock onto.

"People have asked whether I considered *Ranger III* a success," Burke added. "I say, look at it this way. Would you rather that we had the flight with these results, or that we still were expecting it?"

Among objectives *Ranger III* met, JPL listed spacecraft environment control, power, attitude control, communications, trajectory error correction, instrumentation techniques, data handling, understanding of systems interactions. ⌗

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Thiokol's production maturity has given the military highly reliable Pershing and Minuteman—at budget-paring low cost. Minuteman boasts the largest single solid rocket motor ever flown. Recent performance ranks Pershing as the Army's most significant solid-fueled artillery weapon.

FIRST IN
ROCKET PROPULSION

Hyge Shock Tester Highly Versatile

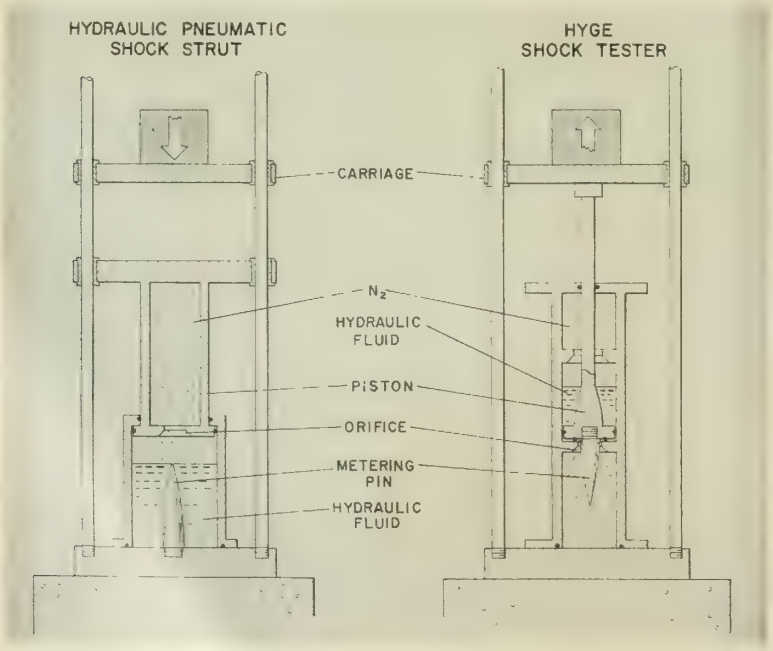
Recently developed units are widely used to test everything in a spacecraft—including man

by William D. Stewart
Application Engineer
Consolidated Vacuum Corp.

DYNAMIC TESTING — long a prisoner of inaccurate measuring techniques—has found wide application in the missile/space industry, thanks largely to advances in accelerometer design and development.

The unbonded strain gage, piezoelectric crystal and other monitoring devices have made it possible to prescribe accurate and reproducible shock environments for dynamic testing of components ranging from large solid rocket motors to sensitive electronic components. Recently, in fact, the techniques have been applied to biomedical experiments to measure the shock tolerance of animals.

• **Methods available**—In the field of shock-testing equipment alone, there are a number of gravity accelerated devices or drop testers—as well as pneumatically-operated testers such as the air cannon, chock tube and Hyge Shock Tester.



DEVELOPMENT OF HYGE UNIT stems from work with Hydraulic Pneumatic Shock Strut. Similarity of the two systems is illustrated above. Basic difference is that the shock strut is a deceleration device, Hyge tester an acceleration system.

Hyge Shock Tester Performance Levels on 6 m.s., ½-Sine Shock Pulses

HYGE SIZE	THRUST NET	MASS RANGE	VELOCITY CHANGE	G'S	EFFICIENCY
3 in.	7500 lb.-f.	5-10 lbs.	206 in./sec.	130	68%
6 in.	33600 lb.-f.	5-10 lbs.	738 in./sec.	475	72%
12 in.	87500 lb.-f.	10-20 lbs.	1290 in./sec.	875	30%

However, successful operation of all of these shock-producing devices depends largely upon the correct accelerometer selection and application. For example, with well-chosen accelerometers, shock environments of 3000 g, of 0.2 millisecond with a ½-sine pulse can be produced on a drop tester. The air cannon and Hyge tester can typically achieve dynamic conditions of 2800 g for 14 milliseconds with a ½-sine pulse and 8 g for 120 millisecond, ½-sine pulse, respectively.

Paradoxically, the need for accurate shock-producing equipment for dynamic testing existed long before methods for accurately measuring shock pulses. Early shock tests, consequently, were specified not by a shock spectrum or shock waveform, but by definition of a shock-producing device.

Conditions for the impact surface and the drop height were spelled out for equipment depending solely on gravity for acceleration or, in the case of pneumatically-operated equipment, by breech pressure or firing pressure.

This meant that the criteria for a satisfactory test depended on the experience and techniques of the test conductor, the acceptable level of damage to a specimen as the result of the test, and the conditions believed to exist in the field.

The most obvious shortcoming of this approach was the difficulty in reproducing in Seattle in February the results of a test run in Philadelphia in December. And, with today's emphasis on reliability and the maximum defense for the least dollars, shock testing of this type has no place in dynamic test programs.

• **Newest test technique**—The most recent type of shock-testing device is the Hyge concept, which was developed because of the need to reproduce in the laboratory the first few milliseconds of the boost-phase shock pattern. Analysis of flight records of several missiles showed that a critical requirement existed for a 40-g modified square wave-

form with a rise time of 10 to 30 milliseconds and a dwell time of 30 milliseconds.

To simulate this relatively high-energy-level condition, a 65-ft. drop tower was used in conjunction with a hydraulic pneumatic shock strut. The shock strut in its many modifications and configurations has been used for many years as a method of producing controlled decelerations in aircraft landing gear, gun recoil mechanisms and many other systems.

The first recorded work done with this type of mechanism, as applied to shock testing as we know it today, was outlined in a paper entitled "Development and Operation of Shock Towers for Missiles and Missile Components" written by Jack Ottestad in April, 1955.

It was during work and experimentation with this device that the Hyge Shock Tester emerged. As shown in the sketch, the two devices are strikingly similar. The basic difference, of course, is that the Hyge Shock Tester is an acceleration device and the hydraulic pneumatic shock strut a deceleration device.

• **How Hyge operates**—Essentially a high-pressure, pneumatic-hydraulic device, the Hyge Shock Tester has thrust or force produced by suddenly exposing the lower side of the thrust piston to high-pressure gas. It is designed to the rigid specifications outlined in the ASTM code governing the construction of unfired pressure vessels.

The Hyge Shock Tester is a two-chamber system with a piston and thrust column in the top chamber. A set pressure is introduced into this chamber, forcing the thrust piston down on an orifice plate sealing around the periphery of the orifice.

The load pressure, introduced into the lower chamber, exerts itself only against the small sealed area on the bottom of the piston. As the load pressure is increased, the pressure/area system in the lower chamber begins to balance that in the upper chamber until finally the two become equal.

As the load pressure is then increased, an unbalanced force situation is created. The force pushing up on the piston overcomes the force pushing down, the piston raises slightly and the seal at the bottom is suddenly released—exposing the entire lower face of the piston to the high-pressure gas and producing the initial thrust.

With the movement of the piston and its displacement from the orifice, the thrust begins to decay in an isentropic expansion. The rate of thrust decay depends on two factors—the volume of the two chambers and the firing ratio. Since the bore and firing ratio

Poly-Scientific... First In High Density Slip Ring Packaging

By Robert H. Miller
Vice President
Research and Development Division

In inertial measurement units, as in most air or missile borne equipment, space and weight are vitally important factors. As over-all volume is reduced, the size limitations on components become more severe. Micro-miniaturized slip ring capsules pioneered by Poly-Scientific, the use of which is growing steadily, permit great space saving by placing the slip ring under the gimbal bearings, thus utilizing formerly wasted space.

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of any given Hyge unit are fixed, the obvious way to expand the energy envelope is to increase the length of the upper and lower chambers.

However, as the piston moves down the cylinder, thrust losses occur from friction and throttling at the acceleration orifice. The total losses become more and more a factor with increasing velocity change. In fact, the degree to which they determine the performance levels and efficiency is shown in the accompanying chart.

• **Waveform also reproducible**—Thrust, however, is not the only requirement in dynamic testing. A shock spectrum or shock waveform—defined in some way by wave form, level and time—is specified and the shock machine must produce this pulse.

By securing a metering pin to the bottom of the thrust piston and providing a specific contour on this metering pin, the thrust-time occurrence can be programed so that as the metering pin is displaced from the orifice specific shock waveforms can be produced.

By means of correct metering pin design, the thrust in any given energy envelope can be controlled by throttling the gas flowing through the orifice. The degree of control the metering pin provides can vary to a greater or lesser degree, and is thereby exploited so that the net result is the desired shock pulse.

When the metering pin forms a minimum of obstruction in the orifice, thrust build-up is rapid and the rise is linear and of the shortest duration. The decay portion also follows the energy envelope. The ¼-cosine pulse so defined is the most efficient utilization of energy and is, therefore, used to provide a maximum velocity change.

On both sawtooth and square waves it is often necessary to have an abrupt decay of one millisecond or less. To accomplish this a deceleration orifice is provided in the set pressure chamber to quickly withdraw thrust. By securing a deceleration metering pin immersed in hydraulic fluid to the top of the thrust piston, the escape path for the hydraulic fluid can be plugged; this, in turn, decelerates the Hyge Shock Tester's internal components. The thrust is rapidly withdrawn and the required acceleration decay produced.

In order to avoid excessive deceleration—caused by the inertia of the piston and thrust column being carried beyond the zero-thrust displacement and pressure buildup in the top chamber—an auxiliary deceleration system is used. This involves rails and a carriage equipped with a pneumatic braking system.

This allows the carriage and specimen to separate from the thrust column and piston so that the latter sees a

HUGE shock tester makes possible pre-launch dynamic tests of missile/space vehicle components—man included. Above are three Hyge units—12-in. tester (foreground) and 3-in. and 6-in. versions in the unique facilities laboratory of Consolidated Vacuum Corporation.

severe deceleration while the carriage and specimen, divorced from these components, experience a mild, low-level square wave of deceleration as they travel up the rails.

• **Wide application** — Since the Hyge Shock Tester can dynamically test everything in a missile or spacecraft—including the man—the system has been used widely.

At present the tester is utilized in dynamic test programs to qualify such things as:

—Acceleration switches and fuses

—Full-scale missile cases and nose cones

—Missile transportation equipment

—Solid-propellant igniters and grain configurations

This list is, of course, not definitive. However, it does illustrate the versatility and almost universal applicability of the Hyge Shock Tester.

Another very broad new field is that of acceleration tolerance determination on animals. A 6-in. Hyge unit at Holloman Air Force Base, for example, produces sawtooth and square shock waveform to 150 g on specimens weighing 50-100 lbs. A 12-in. Hyge unit—producing thrust equal to two-thirds that of the *Atlas* missile—could be used to test humans through a wide range of acceleration levels.

This will make it possible to investigate the shock spectrum which man can tolerate. ⁂

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'Conflict' Uncertainties Resolved

(Text of President Kennedy's memorandum to all departments and agencies on the "conflict of interest" problems of advisers and consultants. See "New Code for Consultants," on opposite page.

The President today issued a memorandum to the heads of all executive departments and agencies, directing them to take administrative steps to assure compliance with existing statutes, rules and regulations governing conflicts of interest problems of advisers and consultants who serve in an intermittent or temporary capacity. This memorandum is of particular significance to those engaged in advising or consulting in research and development on a part-time basis. Hundreds of outstanding scientists and engineers who are regularly employed in industrial organizations, universities or research firms are consulted by the Government in an effort to bring their talents to bear upon the complex and intricate problems involved in Government research and development. This has given rise to questions concerning inter-relations between a consultant's services to the Government and private interests of his own or of his regular employer. The conflict-of-interest statutes antedate the widespread use of part-time consultants and advisers by the Government and have therefore proved inconsistent in some instances and confusing in others.

Legislation designed to amend these statutes is pending in the Congress. In the meantime, it has become necessary to resolve the uncertainties of the existing statutes and to reassure those who are apprehensive that innocent conduct may be deemed wrongful. The memorandum establishes general standards of conduct.

Pertinent Code Sections

Included in the regulations provided by the memorandum are the following:

1. Section 281 of Title 18 of the United States Code in general precludes a Member of Congress, a department head or other "officer or employee" of the Government from representing other persons before the Government departments and agencies for compensation. This statute, first enacted in 1864, sought to prevent the exercise of undue influence by members of Congress and persons regularly employed by the Government. The President has received an opinion from the Attorney General which concludes that the statute applies to all intermittent employees on those days on which they are actually employed by the Government. It also applies during the entire period of their availability for Government service to intermittent employees whose actual employment by the Government comprises a substantial portion of their time. A consultant or adviser who spends 40 per cent or more of his time in actual Government employment is considered by the memorandum issued by the President to be employed for a substantial portion of his time by the Government.

2. The memorandum also points out that a consultant or adviser, whether he serves the Government more or less than 40 per cent of his time, is barred from prosecuting or assisting in the prosecution of another person's claim against the Government during his period of availability for Government service, and two years thereafter.

3. The memorandum disqualifies any consultant or adviser from performing any governmental duties involving the transaction of business with a business firm or other organization by which he is employed, or to which he renders consultant services, or in which he has a financial interest. Moreover, the consultant or adviser may not render any advice in the course of his Government service which will have a direct and predicable effect upon the interests of such firm or organization.

4. The memorandum establishes strict rules of behavior with regard to conflict of interest statutes. No consultant or adviser may use inside information for private gain for himself or persons with whom he has family, business or financial ties; nor may he accept any offer of private employment which he has reason to believe is motivated by his connection with the Government, unless he resigns from his Government position. He may not use his position to coerce, or give the appearance of coercing, any other person to provide any financial benefit to himself or to any person with whom he has family, business or financial ties. And he is not to receive or solicit gifts if he has reason to believe they would not be made but for his Government position, or if the acceptance of the gift would result in the loss of his complete independence or impartiality.

5. Finally, at the time of his appointment, the consultant or adviser must supply the department or agency with a statement of his private employment remuneration, financial interests, including the names of all businesses and other organizations which he serves in any capacity, and the names of the companies in which he holds security and other interests having a significant value. This information must be kept current during the time he is employed.

Nuclear Power Dispute

(Continued from page 13)

to be produced at 7.9 pounds of unshielded system weight per electrical kilowatt.

(Only a little more than $1 million has been put into the program so far, considered only a token amount for a program of *SPUR's* magnitude.)

Aerojet-General Nucleonics (AGN) is responsible for developing the reactor and reactor-loop components; and Westinghouse Electric, the generator and electrical components. Battelle Memorial Institute is, on a limited basis, studying materials and compatibility.

An advanced *SPUR* concept envisions using a thermionic conversion system rather than the Rankine loop. A year ago, AGN was awarded an Air Force contract to look into the feasibility of such a system.

The AEC is said to be still deliberating the question of actively undertaking *SNAP 50* and *SNAP 70*, although indications are that the agency will soon start programs on each system.

SNAP 50 is a Rankine-loop device which will operate in the 1500°F to 2000°F range; *SNAP 70* is the thermionic version, to operate at more than 3000°F. One source put the lowest cost of *SNAP 50* at $250 million.

NASA is pursuing an active R&D effort to learn how to build high-power systems up to tens of megawatts electrical output.

Harold Finger, head of joint AEC-NASA Space Nuclear Propulsion Office, predicts some very tough problems along the way. "We're getting into new life requirements when we talk about 'many years' operation," he told M/R. "How do we develop reliability in this system? It's going to be difficult."

The two basic questions still waiting for an answer: If the task is so costly and difficult and therefore can be done only once, why are three parallel efforts emerging? And if they are to be combined, who is to be in charge? ⁂

The Industry Week

New Code for Consultants

Industry officials who work parttime as scientific advisers to the government now have a new Presidential code of conduct laid down for them. It is intended to resolve possible conflict-of-interest for government consultants who may also work for companies or universities holding government contracts. Major points: advisers are required to keep the government informed of their private financial interests . . . cannot use inside information for private gain . . . and receive a special exemption under conflict-of-interest laws. White House move came after a *New York Times* story attempted to make retired Air Force general Donald Putt an apparent scapegoat because he serves as chairman of the Air Force Scientific Advisory Board while holding the job of president of United Technology Corp. Industry reaction: Unwarranted attack on a man whose record is above reproach. Despite this and the White House move, Congress is expected to look into the subject. Text of Kennedy memorandum is on opposite page.

Changes in the Front Office

Burt Monesmith was named group vice president and James Lyndon vice president-industrial relations of Lockheed Aircraft Corp. Monesmith will have responsibility for activities of Lockheed Electronics Co., Plainfield, N.J., Puget Sound Bridge and Dry Dock Co., Seattle, and Lockheed Propulsion Co., Redlands, Calif. He will retain his present assignment as V.P.-manufacturing. Lyndon, former corporate director of industrial relations, was elected to the newly created post of V.P.-industrial relations. The company also said Elmer P. Wheaton will join March 1 as a vice president, aiding in policy and operational matters, reviewing new business and product plans and providing technical advice. Wheaton had been acting vice president of engineering at Douglas Aircraft Co. . . . *Roy E. Wendahl has been appointed to the new post of executive vice president, Hughes Aircraft Co. Lawrence Hyland, V.P. and general manager, said "Wendahl will run the company from now on, although continuing to report to me in our staff alignment." Wendahl, with Hughes for 22 years, has been a vice president since 1957 and head of its aerospace group since 1958.* . . . Richard E. Krafve has resigned as president of Raytheon Co. Reason given: policy conflicts with other executives. Krafve joined Raytheon in March, 1959, was elected a director and executive vice president in September, 1959, and named president in April, 1960.

News of Mergers and Expansions

Lear Inc. will be merged into The Siegler Corp., pending stockholders' approval this spring. John Brooks, Siegler president, and A. G. Handschumacher, Lear president, said "We believe this merger will provide a substantially expanded and improved defense business capability, linking as it does Lear's know-how and experience in producing high-quality proprietary products with Siegler's military electronic systems and subsystems abilities. The merged organizations will be in a much better position to participate in substantial defense and government outer space projects. . . . *Motorola's Western Military Electronics Center will add some 70,000 sq. ft. of engineering space to its Phoenix, Ariz., facilities.*... Associated Testing Laboratories, Inc. put into operation a 125-g vibration testing system in its Southeastern Divisional Lab, Winter Park, Fla. . . . *Sperry Gyroscope Co. established a regional marketing office in Huntsville, Ala.* . . . Monsanto Research Corp. began start-up operations to manufacture radioactive sources at its Dayton, Ohio, lab. Initial products include fission foils and alpha, beta, neutron, and heat sources. . . . *Digital Dynamics, Inc., nuclear research and instrument manufacturer, opened a new facility in Los Angeles.* . . . General Electric established a unit to speed development of fuel cells as standard electric power sources for space vehicles and military applications. The Direct Energy Conversion Operation comprises components of GE's Aircraft Accessory Turbine Dept. already engaged in direct energy conversion. Headquarters for the operation, a component of GE's Ordnance Dept., are at Lynn, Mass. . . . *Rocketdyne Division of North American Aviation has consolidated its contracting, proposal and marketing activities. Three major line functions, four regional offices and two support activities have been set up. Line functions are: Programs and Contracts; Estimating and Pricing; and Export and Licensing. Customer Services and Market Research will support the organization.* . . . Space Technology Laboratories, Inc. established a systems value analysis section in its special projects department. The section is responsible for cost analyses and system evaluation studies for various system configurations and coordination of these evaluations with systems studies by design engineering and operations research. . . . *General Precision Inc.'s GPL division formed a division to coordinate functions of its research and advanced development activities. Dr. France F. Berger is director of the new Research and Advanced Development department.* . . . North American Aviation's Space and Information Systems Div. will establish a facility in the Tulsa, Okla. area to build various components and GSE for the *Apollo* program. The division will occupy part of AF Plant 3, now occupied by Douglas. NAA also has taken an option on 300 acres of land adjoining the Verdigris River.

Company Name Changes

Texas Instruments Inc. changed the name of its Geosciences Div. to Science Services Div., reflecting the broader scope of its activities. . . . *Magna Corp. is the new title for Magna Products, Inc., a subsidiary of Thompson Ramo Wooldridge Inc.*

New Missile/Space Companies

El-Tek, Inc. has been formed as an electronic technology company in Hawthorne, Calif. Four divisions have been set up: information-technology, communications equipment, control technology and reliability and technical services. President is Dr. M. E. Salveson.

At Solid-State meeting . . .

Tunnel Diodes Called Highly Promising

PHILADELPHIA—While the tunnel diode is not as universally useful in terms of high speed and economy as expected, there are some types of solid-state circuits in which it excels.

That conclusion was presented to last week's International Solid-State Circuits Conference here by P. N. Thompson of Plessey Co., Ltd., of England.

Thompson included among the more promising solid-state computer applications the use of tunnel diodes with very-low-peak tunnel currents for transistorized backward-diode logic circuits and also as high-speed digital storage elements.

At low microwave frequencies, where the tunnel-diode high-frequency characteristics are valuable and its two-terminal properties do not impose severe limitations, Thompson sees an obvious application in low-power oscillators.

He also discussed the use of tunnel diodes as amplifiers. Though application in this area is limited by the two-terminal characteristics, high noise figure in comparison to parametric amplifiers, and by small linear dynamic range, Thompson asserted that tunnel diodes have a very definite place within super-regenerative amplifiers and detectors, where the tuned frequency is not sensitive to the bias voltage.

• **Three-year progress**—There was heavy emphasis on current tunnel-diode technology at the meeting, with an even dozen of the 46 conference papers dealing with practical applications of tunnel-diode techniques which have evolved during the past three years.

Operation of a miniaturized FM telemetering transmitter using a tunnel-diode FM modulator-oscillator was described by a team of scientists from Case Institute in Cleveland. The device was used to broadcast human body activity data to a remotely located receiver and recorder, and reportedly eliminated most of the noise and disturbances encountered when using wire transmission techniques.

A paper presented by Bell Laboratories' M. E. Sikorski described the advantages of tunnel-diode devices for sensitive pressure measurements. The author claims that the devices are among the most sensitive pressure transducers known, and that their small size and response to both static and dynamic pressures makes them extremely attractive in this role.

All four papers presented in the high-speed switching session also dealt with systems employing various tunnel-diode techniques.

Attracting attention in the area was a paper from General Electric's Electronics Laboratory at Syracuse which described a new system of pumped tunnel-diode-transistor computer logic.

A 500-mc data processing rate is reportedly achieved through use of a hybrid transistor-tunnel-diode circuit which combines the high-speed capabilities of both devices. The transistor element provides the isolation between several input channels and also insures proper information flow direction. Since no gain is required from the transistor, operation close to its cutoff frequency is possible. The germanium tunnel diode, which has little isolation capability, provides the gain and threshold action. Reclocking is achieved by pumping the tunnel diode with a 500-mc sine wave.

Total attendance at the three-day conference, including the 10 technical sessions and 11 informal discussion sessions, was estimated at 2000 persons. The 46 papers selected for final presentation to the meeting were culled from approximately 200 submitted manuscripts.

Expanding British, European, Canadian and Japanese activity in solid-state circuitry was indicated by the heavy foreign participation in paper selection and presentation. About 20% of the papers were by foreign authors. ⌗

Mariner 'Flying' to Venus in Simulator

PASADENA, CALIF. — A full-scale temperature control model of the *Mariner* spacecraft has been sealed in the new eight-story, $4-million space environmental simulator at CalTech's Jet Propulsion Laboratory for a three-week "trip" to Venus.

At the end of the test, first in the simulator, JPL engineers expect to know a great deal more about ultimate design of the 450-lb. probe, which is 10 ft. high and 14½ ft. across with its solar panels extended.

The facility was begun in January, 1961, and built on a "full-bore crash program basis" during most of the past year, says W. R. Howard, director of JPL's Engineering Facilities Division. Completion was pressed to enable the maximum number of simulated flights before the launch window for a Venus or Mars flyby arrives, in the third quarter of this year.

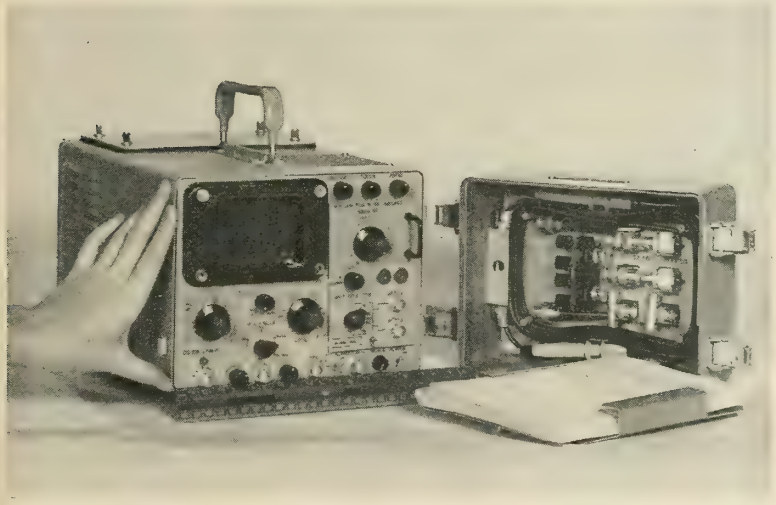
The *Mariner* undergoing the test is a full-size flight configuration model, but not a working model. The test is to check temperature effect on *Mariner's* basic configuration as now envisioned, including how the shadow pattern over it in space will affect heat distribution at various locations both within and without the spacecraft.

"Since the only energy in space is that radiated from the sun, the temperature of a spacecraft will depend upon its distance and orientation relative to the sun, its color or finish, its material and its shape," Herbert D. Strong, Chief of the Environmental Facilities Section said.

The new facility, which will be used to determine final design of all lunar and planetary spacecraft JPL is developing for NASA, consists of a 10,000-sq.-ft. building to house offices, a control room and equipment area and the space simulator. The simulator is a cylindrical tower 80 ft., 4 in. high and 27 ft. in diameter. Lower portion of the simulator is a stainless steel vacuum chamber 47 ft. high and 25 ft. in diameter. Upper portion houses a solar simulation system consisting of 131 arc mercury xenon lamps and a system of lenses and mirrors which produce a collimated beam of artificial sunlight.

The vacuum chamber is lined with 200 dull black aluminum plates. Liquid nitrogen running through small tubes in the lining absorb about 99% of heat radiated from the spacecraft, and diffusion pumps carry away most of the remaining heat to bring chamber wall temperature down to minus 320°F.

The space simulator was built by a team headed by Consolidated Vacuum Corp., a Bell and Howell Company subsidiary, Rochester, N.Y. Other firms include Bausch and Lomb, Pittsburgh-Des Moines Steel, Aetron Division of Aerojet-General Corp., and Tenney Engineering, Inc. ⌗



New Product of the Week:

Lightweight Oscilloscope

AN ALL-TRANSISTORIZED oscilloscope which meets military specifications MIL-E-16400, has been developed by General Atronics Corp. The unit, weighing 23 lbs. and requiring less than ½ cu. ft. of space is designed for submarine, ship, air or spacecraft use or wherever portability, space consumption or heat dissipation must be considered.

In addition to usage as 100% semiconductor it offers a 10:1 reduction drop in power consumption, draws 25 watts and can be adapted for battery use with a converter.

Circle No. 225 on Subscriber Service Card

Scimitar Type Antennas

Scimitar atnennas for P and S bands are in production at Transco Products Inc. The high-power ECM design affords 1.25 VSWR over a one-octave bandwidth and coverage in both vertical and horizontal polarizations. The MIL-qualified antennas operate from −54°C to +95°C and withstand high g loading. The patterns are approximately omnidirectional.

Circle No. 226 on Subscriber Service Card

Vibration Analyzer

The Model 40 Vibration Analyzer, developed by RayData Corp., is a precision analyzer having provision for two separate inputs. Calibrated panel meters indicate the frequency and amplitude of signals in the microinch range from pickups applied to machinery while unbalance phase data is provided by a high-intensity stroboscope flashed in synchronism with the resulting frequency of vibration.

The instrument is not only fully transistorized, with an optional feature permitting battery operation, it also employs a peak hold feature for showing the peak value of transient signals on the meter.

Circle No. 227 on Subscriber Service Card

Underwater Scintillation Detector

Franklin Systems Inc., is producing a transistorized, portable, battery-operated underwater scintillation detector which measures all beta and gamma radiation in the sea to depths of 1000 ft.

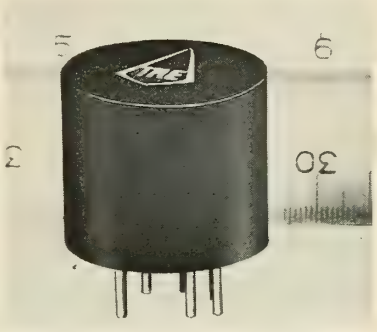
The 58-lb. model 60-4 consists of a submersible detector probe, cable, and readout package and contains a 7-in.-dia. plastic scintillation sphere with a nominal 20 mg/cm² waterproof coating which detects the underwater radiation. The readout package is battery-operated, with a built-in charger, and can be operated for 8 continuous hours before recharge. The unit measures 22 inches long by 9 in. dia.

Circle No. 228 on Subscriber Service Card

Solion Tetrodes

Two solion tetrodes which function as integrators and low frequency amplifiers, have been announced by Texas Research and Electronic Corp. Typical of the applications for integrators are process control, gas chromatography and analog computers. They require very low input power, in the microwatt range, with maximum input currents of 25 and 10 microamps respectively, and give outputs of up to 1 milliamp which are proportional to the time integral of the inputs.

Circle No. 229 on Subscriber Service Card



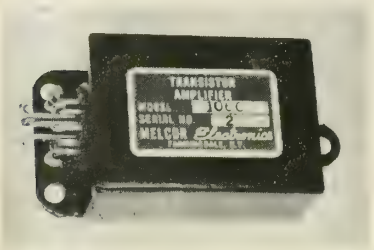
Multiple Output Power Supply

Three isolated outputs, each delivering a voltage from 0 to 50 VDC at 500 milliamperes, are obtained from one package measuring 5¼ in. x 19 in. x 8¼ in., available from Valor Instruments Inc. A high degree of flexibility is offered by installation of up to three standard MB type plug-in modules. Voltage and current of the three modules are monitored on a wide-face meter and voltage adjust, and fuse of each module protrudes through the front panel for ease of adjustment and accessibility.

Circle No. 230 on Subscriber Service Card

Transistorized Amplifiers

A transistorized summing amplifier providing quadrature rejection at the null point in a servo loop, is being offered by Melcor Electronics Corp. Known as Model 1060, it weighs less than 2 oz. and features 150:1 quadrature rejection ratio, operation at 400



cps, low noise characteristics, and summing accuracy of ±.05% and 200 K input impedance.

The unit meets military shock and vibration specifications, operates over the temperature range −55°C to +80°C, prevents saturation of the loop by spurious signals, and insures high system accuracy.

Circle No. 231 on Subscriber Service Card

Recording Camera

The Royco Model 500 airborne-particle recording camera produces finished photographic records of particulate distribution and concentration 10 seconds after the drawing of a sample. It is fabricated of aluminum, with a carrying case for field use, and requires no special skills or materials. Either prints or slide transparencies can be made. It offers a rapid method for checking air-filter operations or applying quality-assurance methods to particle-grinding or sizing processes in sizes from 1 micron.

Circle No. 232 on Subscriber Service Card

Solid-State Demodulator

A compact, solid-state ten-tone demodulator, made by Casa Electronics Corp., provides a ten-channel tone separation and demodulation system for use in conjunction with telemetering systems. This general purpose instrument is used to obtain ten bits of information from one sub-carrier channel.

Plug-in printed circuits are used throughout. Standard frequencies range from 33 to 402 CPS, with provision for connection of external filters to provide various alternate frequencies on each channel. Bandwidth of each channel is 20 CPS.

Circle No. 233 on Subscriber Service Card

Micro-Inductors

Unique ultra-fine wire winding techniques, and a new concept in design and construction, enable new micro-inductors to withstand more than 10,000 G's. Designed by Clippard Instrument Laboratory, Inc., for relatively low current circuitry in rockets, missile and space-age miniature equipment where extreme mechanical ruggedness and resistance to environmental change is desired, these ferrite-cored inductors are supplied in three styles. All exceed MIL-C-15305A, Grade 1, Class 0, environmental requirements.

Circle No. 234 on Subscriber Service Card

Resistance Wafer Kit

A kit containing 10 cermet resistor micro-elements for use in micro-module experimentation is available from CTS Corp. The resistance wafers, called CERAFERS, are rated at 100, 500, Lk, 2.5K, 5K, 10K, 25K, 50K, 100K and 250K ohms, ±10%, in short straight paths without resorting to lattice or grid patterns. Each wafer has two resistors of the same value on one side.

Circle No. 235 on Subscriber Service Card

Dual Centrifugal Blower

A dual centrifugal blower has been developed by The Torrington Mfg. Co. to fit into restricted space in tightly packed electronic equipment. It features an air-tight mounting flange which eliminates the need for costly ducting joints, and guaranteed air flow output is 180 cfm at 0.5 in. of water (standard density). The blower, measuring 10.81 in. long, 5.25 in. high and 4.78 in. deep, and weighs 6 lbs.; the 208-volt, 400-cycle motor operates at speeds between 5600 and 5900 rpm.

Circle No. 236 on Subscriber Service Card

Semiconductor Furnace Assembly

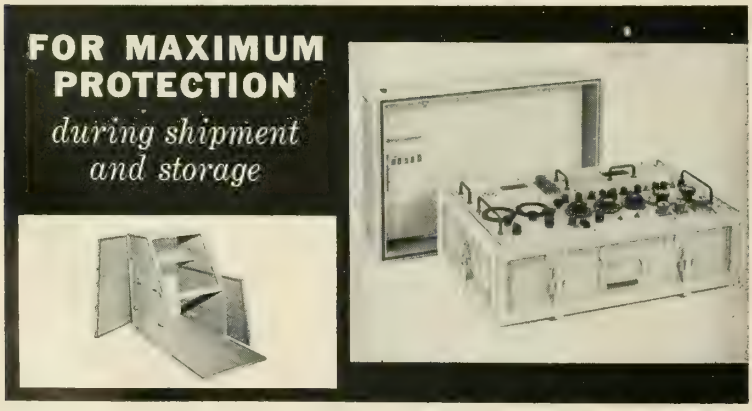
A three-zone element in a special 36-in. furnace assembly has been developed by Kanthal Corp. to provide the temperature uniformity required for semiconductor production. At an average temperature of 1130°C in the furnace, the three-zone element maintains temperatures within ±3°C over 14 in. of the hot zone. The three-zone element is also available alone.

Circle No. 237 on Subscriber Service Card

Servo Gear Assembly

Kinetic Instrument Corp. announces the manufacture of a subminiature precision servo gear assembly designed for two size 11 and two size 8 components. Overall ratios as high as 5000:1 may be obtained with exact integral ratios between all components from the unit, which measures 1 in. x 1⅛ in. x 1¾ in. Backlash can be held to less than five minutes of arc.

Circle No. 238 on Subscriber Service Card



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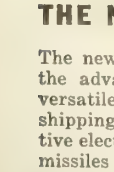

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names in the news

RENNE

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Dr. James R. Burnett: Will direct the *Minuteman* ICBM Weapon System Program at Space Technology Laboratories, Los Angeles.

Col. George E. Howard, Jr.: Former Director of Operations, 12th Air Division, March AFB, Calif., appointed Chief of Staff, 1st Strategic Aerospace Division, succeeding Col. James H. S. Rasmussen, reassigned to Langley AFB.

John J. Crowley: Former Director of Guided Missiles Office, Assistant Secretary of Defense for Engineering, and vice president and assistant general manager of Grand Central Rocket (now Lockheed Propulsion Co.), has been appointed chief project engineer, Army guided missile programs of General Dynamics, Inc., Pomona, Calif.

George J. Renne: Treasurer of Beckman Instruments, Inc., of Fullerton, Calif., has been named a vice president of the company.

William C. Chambliss: Has been selected to fill the post of director of planning and also to serve on the board of California Computer Products, Inc., Downey, Calif.

Dr. Arch C. Scurlock: President of Atlantic Research Corporation, has been elected chairman of the board at Nuclear Science and Engineering Corp., Pittsburgh, Pa.

Kilbourne H. Knox: Promoted to the position of vice president in charge of sales for Weston Hydraulics, Ltd., Van Nuys, Calif.

Stanley Hauer: To head the new Systems Value Analysis Section in the Special Projects Department of Space Technology Laboratories, Los Angeles.

Stewart Pfannstiel: Has been elected to the new position of senior vice president by the directors of Oak Manufacturing Co., Crystal Lake, Ill.

Louis H. Benzing: Appointed director of operations, military systems, Lockheed Electronics Co., a division of Lockheed Aircraft Corp.

Col. Kenneth E. Hill: Wing Director of Operations, will assume command of the 4751st Air Defense Wing (Missile) and Hurlburt Field, Fla., on March 18, when **Col. Joseph Myers,** present commander, leaves for his new ADC assignment.

George Thompson: Has joined Microtech, Inc., Cheshire, Conn., as vice president and general manager.

Oscar S. Cox: Senior member of the Washington, D.C., law firm of Cox, Langford, Stoddard and Cutler, has been elected a director of American Machine & Foundry Co.

Donald M. Wilder: Will fill the newly established position of director of administration in the Lockheed-California Co., Burbank, Calif., a division of Lockheed Aircraft Corp. **Frank A. Mathey** will succeed Wilder as director of financial operations.

Donald T. Spaulding: Named president of the Federal Systems Division of International Business Machines, Corp., Rockville, Md. He succeeds **Charles Benton, Jr.,** who has been appointed executive assistant to **Orland M. Scott,** IBM vice president and group executive for the Data Processing and Federal Systems Division.

Leon I. Bawer: General Sales Manager of General Communication Co., Boston, has been elected a vice president of the company.

Joseph F. Engelberger: President of Consolidated Controls Corp., Stamford, Conn., and vice president of its parent company, Consolidated Diesel Electric Corp., has been named to the board of directors of the parent company.

William F. Tait: Former manager, Marketing, Government Services, has been promoted to division vice president, Marketing, Government Services, Radio Corporation of America Service Co., New York.

R. D. Calvert: Division general manager of Lear, Inc.'s Electro-Mechanical Division, Santa Monica, Calif., has been elected a vice president of the firm.

David L. Watson: Former vice president in charge of engineering and production, has been named president of Universal Dynamics Corp., Alexandria, Va.

Questions and Answers about the

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What capabilities? From which subsidiary of RCA?

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AIR FORCE

$29,175,673—**Systems Development Corp.**, Santa Monica, Calif., to continue development and installation of a training program for the Air Defense Command's *SAGE* defense system.

$26,136,676—**Boeing Co.**, Seattle, for R&D on the *Minuteman* weapon system, to include missiles, flight test, development of support equipment, protective cabinets for electronic equipment, and depot tooling for assembly and disassembly (3 contracts).

$15,857,000—**Aerojet-General Corp.**, Sacramento, Calif., for research and development of the *Minuteman* stage II motor, and for fabrication and delivery of *Titan II* propulsion systems and related equipment (3 contracts).

$8,820,000—**Philco Corp.**, Western Development Laboratories, Palo Alto, Calif., for continued production of a satellite control subsystem.

$7,600,000—**General Dynamics Corp., Telecommunications Division**, Rochester, N. Y., for three additional *Titan* missile bases and a training facility, to be installed at Davis-Monthan, McConnell, Little Rock and Vandenberg Air Force Bases.

$4,545,739—**General Electric Co.**, Philadelphia, for development and production of a *Titan II* re-entry vehicle.

$3,266,800—**Paul Hardeman, Inc.**, Stanton, Calif., for installation and checkout of *Titan II* propellant transfer systems (supplemental contract).

$3,155,000—**North American Aviation, Inc.**, Canoga Park, Calif., for support of a NASA rocket engine program (supplemental contract).

$3,000,000—**Federal Electric Corp.**, Paramus, N. J., for installation of an interim tropospheric scatter communications system in the Mediterranean area.

$3,000,000—**Lockheed Aircraft Corp.**, Sunnyvale, Calif., for provision of *Agena* equipment and launch support (supplemental contract).

$2,500,000—**General Dynamics Corp.**, San Diego, for procurement of personnel subsystems for *Atlas* missiles.

$1,365,000—**Avco Corp.**, Everett, Mass., for research on re-entry objects (supplemental contract).

$1,240,374—**Texaco, Inc.**, New York City, for basic chemical research for development of a new storable liquid rocket propellant.

$1,000,000—**Douglas Aircraft Co.**, Santa Monica, Calif., for production planning for the *Skybolt* program.

$500,000—**Martin Marietta Corp.**, Baltimore, for development of fabrication techniques and design procedures for refractory metal honeycomb sandwich panels for space vehicle construction.

$443,994—**Barrett-Moore and Associates**, El Paso, Tex., for modification of Building 1264, Holloman AFB, N. M.

$235,007—**General Electric Co.**, Syracuse, N. Y., for production of test instrumentation and components for an air weapons control system for defense against air-breathing weapon systems.

$111,619—**Canoga Electronics Corp**, Fort Walton Beach, Fla., for infrared measurement systems.

$82,230—**Aero-Space Division, Boeing Co.**, Seattle, for kits, spares and descriptive identification data for the spares to support the *Bomarc* weapon system.

$62,650—**Atlantic Research Corp.**, Alexandria, Va., for rocket motors and ignitors for *SM-75* missile with related ammunition and engineering data.

ARMY

$11,825,000—**General Dynamics/Pomona**, Calif., for continuation of R&D on the *Redeye* missile system and on the *Mauler* weapon system (2 contracts).

$1,687,920—**Sperry Rand Corp.**, Salt Lake City, Utah, for repair parts, ground support and missile items for *Sergeant* guided missile system (4 contracts).

$783,909—**Gilfillan Bros., Inc.**, Los Angeles, for spare parts for the *Corporal* missile system.

$419,237 — **Intercontinental Manufacturing Co.**, Garland, Tex., for rocket motor and nozzle, metal parts assemblies, *Sergeant* missile system.

$419,000—**Trip Construction Co., Inc.**, Glenside, Pa., for construction of improved *Nike-Hercules* control system.

$393,080—**Lockheed Propulsion Co**, for research of structural integrity of propellant grains.

$237,000—**Missile Sites, Inc.**, Silver Spring, Md., for construction of improved *Nike-Hercules* control system.

$149,060—**Western Electric Co., Inc.**, New York City, for procurement of *Nike* replenishment repair parts.

$95,286—**Martin-Marietta Corp.**, Orlando, for *Pershing* weapon system, and for repair parts for *Lacrosse* missile system (2 contracts).

$83,678—**Douglas Aircraft Co.**, Santa Monica, Calif., for *Nike Hercules* portable test set dolly.

INDUSTRY

$1,080,000—**Military Products Division, Hamilton Watch Co.**, Lancaster, Pa., from **Sandia Corp.** for timing devices, and from **Boeing Co.** for programing devices and spare parts for the *Bomarc* missile (2 contracts).

$475,000 — **Ortronix Incorporated**, Orlando, Fla., from **Aerospace Div, Martin-Marietta Corp.**, for high-speed automatic digital multimeters for use in the ground support equipment of the *Pershing* missile program.

NASA

$685,000—**Dynamics Science Corp., Marshall Industries subsidiary**, San Marino, Calif., for research on a high-energy rocket propellant, aircraft safety, interplanetary vehicle sterilization, rocket combustion instability, satellite, bio-medical packages, rocket guidance control and high-temperature lubricants (joint contract with Air Force and **Lockheed**).

NAVY

$2,960,276—**Philco Corp.**, Philadelphia, for modification and repair of control sections of *Sidewinder* missiles.

$2,500,000—**Northrop Corp., Ventura Division**, for production of *KD2R-5* radio-controlled aerial target drones.

$2,421,503 — **Aerojet-General Corp.**, Sacramento, for rocket motors and ignitors for *Tartar* missiles.

$1,940,000—**Chromcraft Corp.**, St. Louis, for launchers for folding-fin rockets for fighter aircraft.

$1,200,000 — **Goodyear Aircraft Co.**, Akron, Ohio, for continuation of research and development on *Subroc* missile system.

$586,000 — **Vitro Corp. of America**, Silver Spring, Md., for research and development of shipboard launching system for *Terrier, Tartar, Talos* and *Typhon* missiles and for engineering and preliminary design of facilities for shipboard stowage, handling and checkout of Navy missiles.

$140,000—**Vought Range Systems, division of Chance Vought Corp.**, Dallas, Tex., for services of personnel for operational and technical support of guided missile unit No. 55.

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Staff level openings in Orlando, Florida, are available for outstanding technical contributors in radar systems technology.

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—when and where—

FEBRUARY

Tracking and Command of Aerospace Vehicles, Institute of the Aerospace Sciences, Jack Tar Hotel, San Francisco, Feb. 19-21.

Electrical Insulation Conference and Exhibit, American Institute of Electrical Engineers, Shoreham Hotel, Washington, D.C., Feb. 19-22.

Society of American Military Engineers Southwestern Regional Conference, El Paso, Tex., Feb. 23.

Third Annual Symposium on Nondestructive Testing of Aircraft and Missile Components (Southwest Research Institute), Gunter Hotel, San Antonio, Tex., Feb. 27-Mar. 1.

Application of Switching Theory in Space Technology, symposium sponsored by Air Force Systems Command, Air Force Office of Scientific Research, and Lockheed Missiles and Space Co., Sunnyvale, Calif., Feb. 27-Mar. 1.

MARCH

Institute of Radio Engineers, 8th Scintillation and Semiconductor Counter Symposium, Washington, D.C., Mar. 1-3.

Pittsburgh Conference on Analytical Chemistry and Applied Spectroscopy, sponsored by the Society for Analytical Chemists and the Spectroscopy Society, Penn-Sheraton Hotel, Pittsburgh, Mar. 5-9.

Fifth Annual Technical Conference Society of Vacuum Coaters, Sheraton-Cleveland Hotel, Cleveland, Mar. 6-7.

Society of American Value Engineers (SAVE) Annual Meeting, Marriott Motor Hotel, Washington, D.C., Mar. 6-7.

Armed Forces Communications and Electronics Association, Cape Canaveral Chapter, symposium, Cocoa Beach, Fla., Mar. 6-8.

Flight Propulsion Meeting (classified), Institute of the Aerospace Sciences, Cleveland, Mar. 8-9.

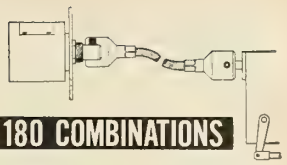
American Society for Quality Control, Middle Atlantic Conference, Statler-Hilton Hotel, Washington, D.C., Mar. 8-9.

First Microminiaturization Congress and Exhibition, sponsored by American Watchmakers Institute, Hotel Commodore, New York City, Mar. 10-13.

National Electrical Industries Show, New York Coliseum, New York City, Mar. 11-14.

1962 Symposium on Packaging of Chemical Products, sponsored by Manufacturing Chemists Association, Inc., St. Louis, Mar. 13-14.

Goddard National Space Conference, sponsored by the National Rocket Club, Sheraton Park Hotel, Washington, D.C., Mar. 14-16 (Goddard Memorial Dinner on Mar. 16).



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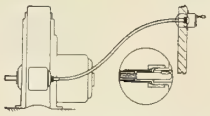

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Good Long Range Planning

WE HAVE HEARD many times a complaint from friends in the industry which goes something like this:

"The big trouble in trying to help the services with their problems is finding out what those problems are."

Almost all of the prime manufacturers in the missile/space industry maintain large departments devoted to seeking out the future problems and requirements of the military. These bear such names as Long-Range Planning or Advanced Planning. They not infrequently take the form of an intelligence group of which CIA could be proud. It is not unknown for such a well-informed unit to detect a military need before the military itself becomes aware of it, thereby effectively orienting a company sales program.

Smaller concerns in the industry cannot afford the expense of this type of operation. And even the best Advanced Planning department cannot ferret out every potential military requirement.

It therefore is a duty of the military services to keep their industrial partners as fully informed of requirements—and problems—as possible. The Navy, for example, has for some time sponsored a series of regional meetings with manufacturers on its R&D requirements.

We are reminded of all this by another example of sound military planning which has just crossed our desk. We want to call attention to it because the industry, too, has a duty in this.

When the military outlines its problem areas and asks for industry help, responsible missile/space firms should be quick to respond. It not only is in the national interest—it offers a sound lead to future contracts.

The particular example we are discussing is the Air Force-industry symposium on future trends in range testing and instrumentation development, scheduled at Patrick Air Force Base, Fla., March 6-8.

Patrick is headquarters for the Atlantic Missile Range. Here, the Army, Navy, Air Force and civilian agencies work together on the problems of the missile and space test range.

To use the Air Force description: "Cape Canaveral, as the launching site for the range, is the first of a gigantic far-flung network of tracking stations, set out like stepping stones down the 10,000-mile range."

Operating the range under contract from the Air Force is Pan American Airways. Data-gathering, instrumentation and evaluation are handled by Radio Corporation of America under contract from Pan Am.

They will take part, with the Air Force, in the March symposium. It has two purposes: to acquaint industry with the future needs of the nation's ranges and to aid members of the AMR staff in getting first-hand information on new industrial developments in the field.

It will not, in fact, be limited to AMR. Full support is being extended by the agencies at White Sands and the Pacific Missile Range. The meeting will lead off with a description of long-range technical problems facing all the national ranges.

We asked Gen. Leighton I. Davis, commander of AFMTC, just what he had in mind in setting up such a conference, first of its kind for the Atlantic Missile Range. Here's his reply:

"The purpose, of course, is to encourage industry to investigate some of these problems with its own funds. It is obvious that the nation is going to spend a lot of money on range instrumentation and global networks in the next few years. Those companies which are alert to the basic limitations of our present equipment and systems, and are willing to invest some of their own funds, will be in a better position to help us when it comes to equipping the ranges."

THAT IS LAYING IT ON the line bluntly. And it is the kind of challenge to which the industry should respond. The firm looking for something for nothing will not find much of value in this conference. But the company seeking some sound guidance on where to invest its R&D funds in this field will be aided considerably.

Gen. Davis knows what he is talking about when he speaks of "a lot of money" for future range instrumentation. The National Aeronautics and Space Administration Fiscal '63 budget alone provides over $359 million for Cape Canaveral and AMR, much of it to be spent in this field. The Air Force, of course, has responsibility for the operation of AMR. A good part of the military budget itself will be spent on the ranges.

Electronics firms represented at the conference will come away with increased awareness of military needs. They also will have an unusual opportunity to brief military planners on the latest industrial developments in their area.

We have been quick to editorialize against what we regard as unnecessary conferences and symposiums. We want to be equally quick to support what promises to be a useful meeting.

Gen. Davis, and the local technical societies which are participating in sponsorship of the Patrick symposium, have come up with a good idea. We hope the industry wholeheartedly takes them up on it.

Information on the meeting can be obtained from Col. R. W. Swanson, Deputy Chief of Staff, Operations, Air Force Missile Test Center, Patrick AFB, Fla. All sessions will be unclassified.

William J. Coughlin

How Science Serves Defense at Westinghouse...Airborne Radar

Phantom II . . . the fastest, highest-flying fighting aircraft.

Firepower CONTROL

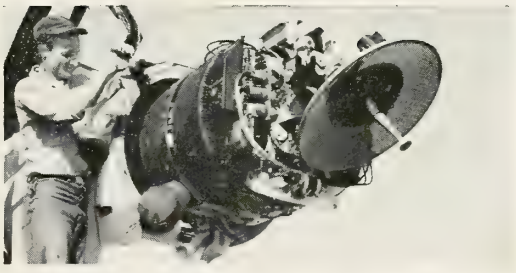
In defense or attack . . . in any weather . . . the Navy's new McDonnell F4H is a mighty potent fighting aircraft. It carries a variety of weapons . . . and relies on one of the most advanced and accurate airborne missile control radars ever built, the APQ-72 by Westinghouse.

Now operational, the APQ-72 is a proved radar. Long range. All-weather. Designed and packaged for high reliability and ease of maintenance, with "built-in" test features.

This modern, airborne radar is the latest in a succession of outstanding applications, which include the Bomarc target seeker and the Aero-13 system for the F4D "Skyray". It is another example of Westinghouse leadership in aerospace electronics.—Defense Products Group, 1000 Connecticut Avenue, N.W., Washington 6, D. C.

You can be sure . . . if it's Westinghouse. J-02313

Westinghouse

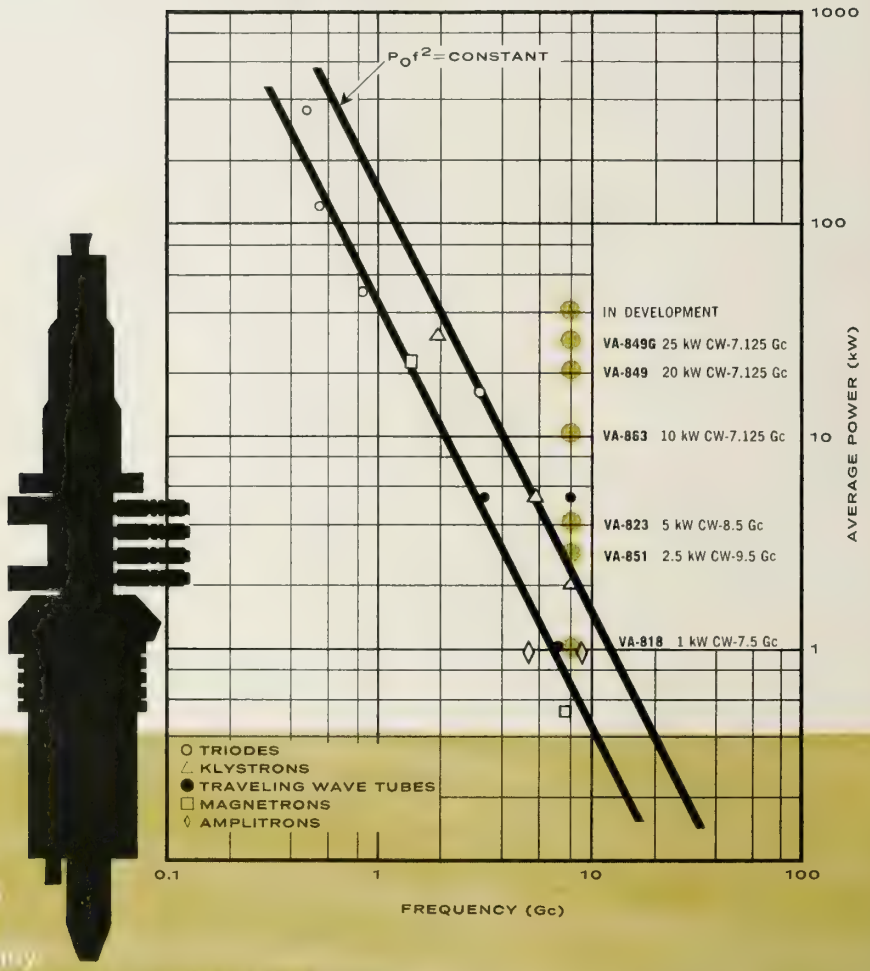


Years of airborne electronics experience at Westinghouse with such radars as the Aero-13 system in the Douglas F4D, and the Boeing Bomarc have produced many state-of-the-art advances. These are incorporated in the all-new APQ-72 system.

Accuracy and long range of the APQ-72 system were demonstrated during the 1961 record-setting Bendix Trophy race. It located tanker aircraft long before they were in sight, helping cut aerial refueling times in half.

Circle No. 6 on Subscriber Service Card

AVERAGE POWER OUTPUT AS A FUNCTION OF FREQUENCY
FOR MICROWAVE TUBES. (MODIFIED FROM NERGAARD)



Power surveys by Nergaard,* plotting power output as a function of frequency for tubes of varying powers, predicted that minimum wattage available in X-band would be less than 10 kW CW.

Varian research indicates this figure to be extremely conservative. Varian's recent introduction of the VA-849 amplifier klystron provided the industry with a tube capable of developing 20 kW CW power at 7.125-8.5 Gc. A modified VA-849 developed 51.5 kW power in the laboratory, and is now available as the VA-849G, conservatively rated at 25 kW CW. Varian accomplishments do not stop there. The company is now developing an X-band tube rated at a *minimum* of 50 kW CW.

If *your* microwave project calls for such out-ahead capability in power tube development, write Tube Division. *L. S. Nergaard, RCA Review, Dec., 1960

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FEBRUARY 26 1962

missiles and rockets

THE MISSILE/SPACE WEEKLY

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John Glenn—Safely Back from Orbit

SPECIAL REPORT ON FRIENDSHIP 7 . . . .
Aerojet Experience Breeds New Success .
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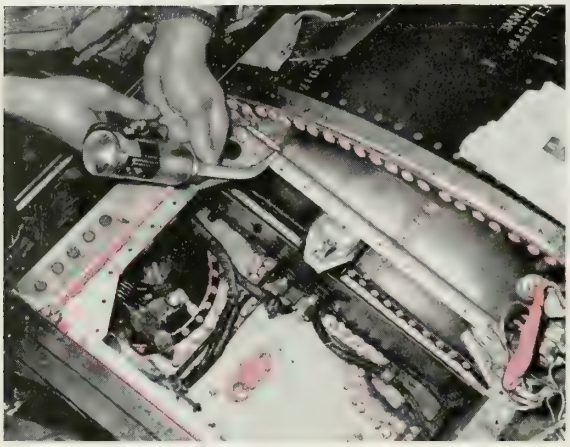
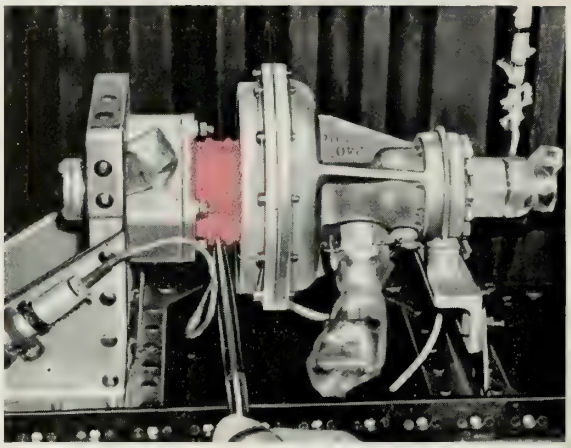
AN AMERICAN AVIATION PUBLICATION

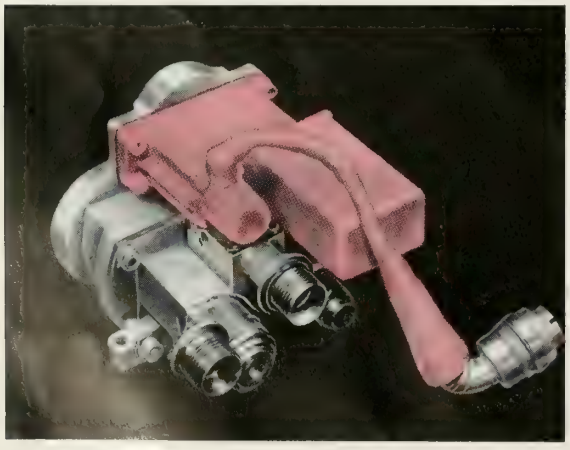
GENERAL ELECTRIC RTV SILICONE RUBBER KEEPS THE PRESSURE IN THE X-15!



Critical pressurized areas of the X-15, designed and built by North American Aviation through a joint NASA-Air Force-Navy research project, are sealed with General Electric RTV (room temperature vulcanizing) silicone rubber. After a thorough analysis of all high temperature sealants, RTV was selected to seal the aft bulkhead behind the cockpit, instrumentation compartment and shelving near the ship's mid-section.



RTV adhesive seals heating blanket for helium pressure regulator. RTV rubber forms tenacious bonds to most materials provided surfaces are properly primed. It is easily removed from unprimed surfaces. It can be applied by dipping, pouring, spraying or buttering—cures in place at room temperature to form a tough, flexible seal. Cure times can be varied from minutes to hours depending on catalyst used and heat, if applied.



Protection against hydrogen peroxide spillage is provided by RTV silicone rubber coating on this three position actuator. RTV is commonly used to protect against moisture and many chemicals. It's used in almost all U.S. missiles and space vehicles, not only for sealing, but for electronic potting and encapsulating, and as thermal insulation. It combines excellent electrical properties with physical protection.

If you would like a free sample for evaluation, write on your letterhead, describing your application. Section O266, Silicone Products Department, General Electric Co., Waterford, N. Y.

TYPICAL PROPERTIES OF RTV SILICONE RUBBER

	RTV-11	RTV-20	RTV-40	RTV-60	RTV-77	RTV-88	RTV-90
Viscosity, Poises	120	300	450	550	8,000	10,000	12,000
Color	White	Pink	White	Red	White	Red	Red
Consistency	Easily Pourable	Pourable			Spreadable Thixotropic Paste		Stiff Paste
Temperature Resistance	FROM −90°F TO +600°F FOR EXTENDED PERIODS TO 9,000°F FOR LIMITED TIME AS THERMAL INSULATION						
Specific Gravity	1.18	1.35	1.37	1.47	1.33	1.47	1.47
Radiation Resistance	10^7 ergs/gram						
Tensile Strength, psi	350	450	550	650	500	750	750
Shrinkage, %	0.4	0.2	0.2	0.2	0.3	0.3	0.2
Durometer, Shore A	45	50	55	60	50	65	60
Volume Resistivity, ohm-cm	6×10^{14}	5×10^{15}	1×10^{14}	2×10^{14}	1×10^{15}	1×10^{14}	2×10^{14}
Solids Content, %	100	100	100	100	100	100	100
Elongation, %	180	140	120	110	220	110	190

A wide range of RTV compounds meet a variety of application requirements. Low viscosity RTV-11 (or transparent LTV-602) is used for potting electronic assemblies and coil impregnation. RTV-77, 88 and 90 are mainly used for high-temperature sealing and for thermal insulating and ablative applications. Intermediate viscosities meet other insulating and sealing requirements, are also used as flexible mold materials.

GENERAL ELECTRIC

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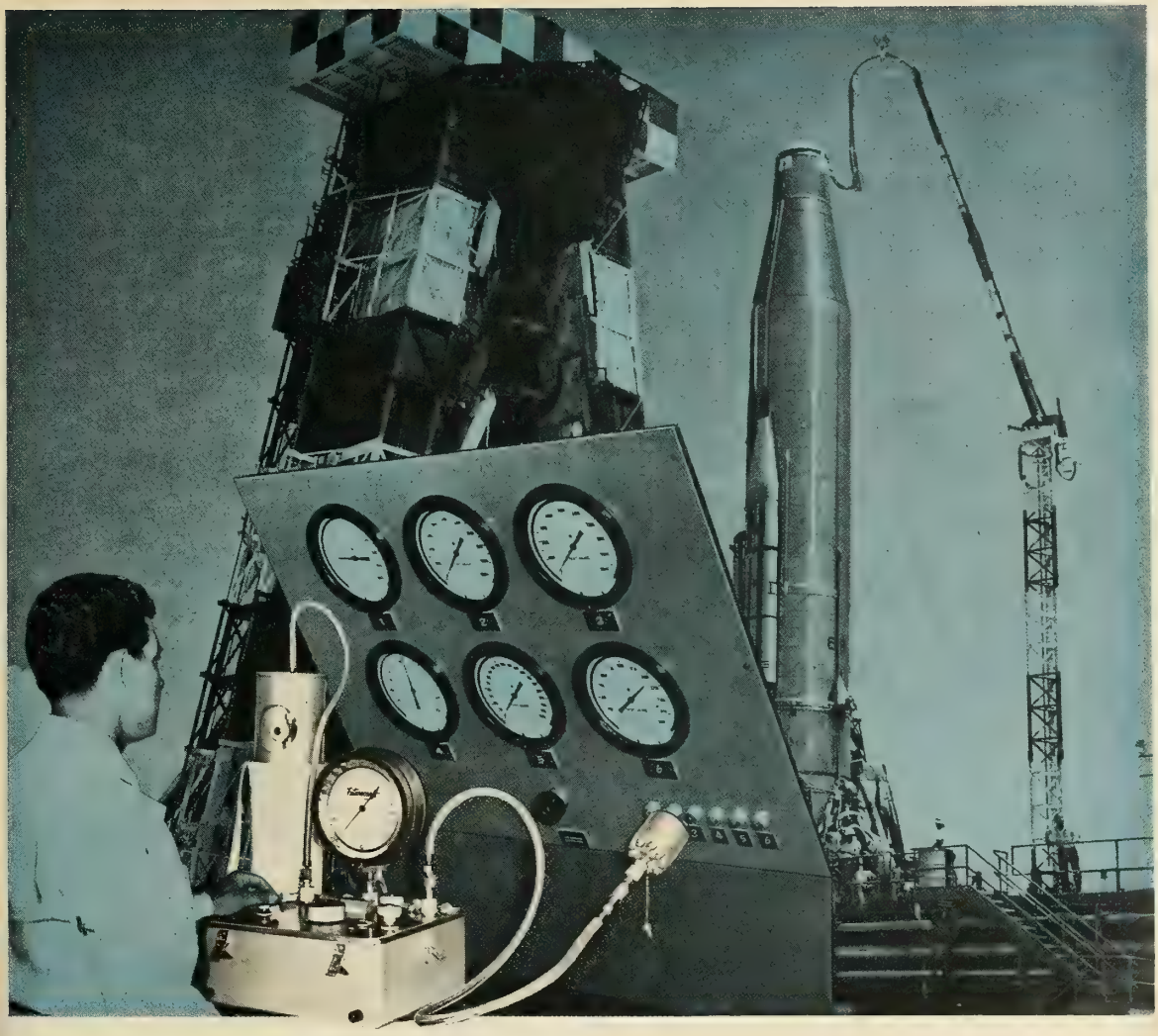

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THE MISSILE / SPACE WEEKLY

missiles and rockets

Volume 10, Number 9 February 26, 1962

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THE COVER

Free World's first orbiting astronaut made historic MA-6 shot a three-orbit success by taking personal control of spacecraft. U.S. manned orbit program will be accelerated. Special M/R reports starts on p. 13.

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letters

Small Business Apathy?

To the Editor:

Your Dec. 11 editorial ("Two Sides of the Patent Coin") gave only an edge-on glimpse of the coin. Your conclusion, however, that "the major firms will find little support from small business" is well-founded. In the extensive hearings concerning Federal patent policy held by the Senate Subcommittee on Patents, Trademarks, and Copyrights, very few representatives of small business had enough interest in the battle to appear before the subcommittee. The battle for patent rights is a fight between "big" business and the government.

In Fiscal 1961, 99.8% in dollar volume of all prime contracts for research and development (excluding those for less than $10,000) was awarded by the Department of Defense to 500 contractors. Of this 500, 110 were government agencies, universities or other non-profit institutions. Of the remaining 390 "private" contractors, the top 25 is in the "big" business class.

The big military contractors do most of the R&D work themselves and, as a corollary, the amount of work that is subcontracted is an extremely small percentage of the prime R&D contracts. Moreover, the small amount of R&D work that is subcontracted is commonly awarded to the "big" companies.

Where a small business makes an invention, the research and developmental costs are usually paid out of the private funds of the business. Not having a substantial part of the government-financed R&D work, the small businesses are content to let the big military contractors bear the battle. The attitude of small business toward the outcome of the fight up to now has been one of indifference.

The DOD policy of indiscriminately permitting its military contractors to retain commercial rights in inventions made in the performance of R&D contracts is certain to have an adverse effect upon small business. A recent study of the same Senate Subcommittee has shown that though many such inventions are patented, few are used in commercial products made by the contractor. Since the contractors, generally, have no commercial products to protect, why do the contractors want the commercial rights to the inventions? The answer is evident. The military contractors hope to control newly developing fields of commercial enterprise through their patents. The probable course of the military contractor would be to at first control the incipient field by exacting royalties for use of the patented invention. When the field develops to the stage where it is lucrative, the military contractor may be expected to insert himself into the field through the leverage of his patents.

As a general rule, the smaller businesses initially develop the new fields of commercial enterprise. For any business, whether large or small, to assume the risks

of pioneering new commercial fields and then be compelled to pay royalties to a patent owner who made his invention in the performance of a relatively riskless governmental R&D contract and did nothing with the invention except patent it, is extremely dispiriting and tends to dampen the initiative of the enterprising to enter new commercial fields.

Louis L. Orenbuch
Boston

Lunar Solar Energy

To the Editor:

In reference to your article, "AF Lectures Cover Host of Lunar Problems" (M/R, Jan. 22, p. 28), I would like to bring out some interesting points regarding the lunar day and night. The report mentioned the necessity of nuclear power as a source of photosynthetic regeneration of the environment in the absence of the sun for half the time, and the sun itself would be a very rich source of energy during the two-week-long lunar day.

I have an idea that there are portions of the moon which are *continually* basking in sunlight, so that a solar generator placed in these locations would provide this economical energy at all times. This thought takes a small amount of research and calculation: it is a fact that the moon has a pole which is directed toward a fixed point in space, so that the moon, like the earth, has tropics and an arctic circle. These zones, however, are not as clearly defined as the earth's because the moon's motions are much more complex and variable. But from data in the *American Ephemeris* almanac, we find that, through the years, the moon's arctic circle is never further than two degrees of arc from its pole (as compared with 23½ degrees for the earth). In other words, from a level vantage point on the pole of the moon, there will be six months' midnight sun when the sun reaches a maximum altitude of less than two degrees above the horizon; and six months of darkness when the sun dips a maximum of less than two degrees below the horizon.

Now suppose we place a generator on a mountain. We find from trigonometry that the lunar horizon "dips" two degrees from a mountain just 3500 ft. high. If such a mountain were located upon a lunar pole, or in its immediate vicinity, the generator would be exposed to sunlight at all times, provided that higher mountains to not obstruct the horizon. To reduce the situation to practicality, we know that there are very high mountains, the Leibnitz Mountains, near the lunar south pole. Heights up to 33,000 ft. have been measured, so that it would not be unreasonable to suppose that many of these lofty peaks are in sunlight at all times, except for brief intervals of obstruction from neighboring peaks.

And if there is worry about human exposure to the heat, or the rapid changes of temperature, I am sure there would be adjacent valleys in continuous darkness.

Brian T. O'Leary
Astronomy Graduate Student
Georgetown University
Washington

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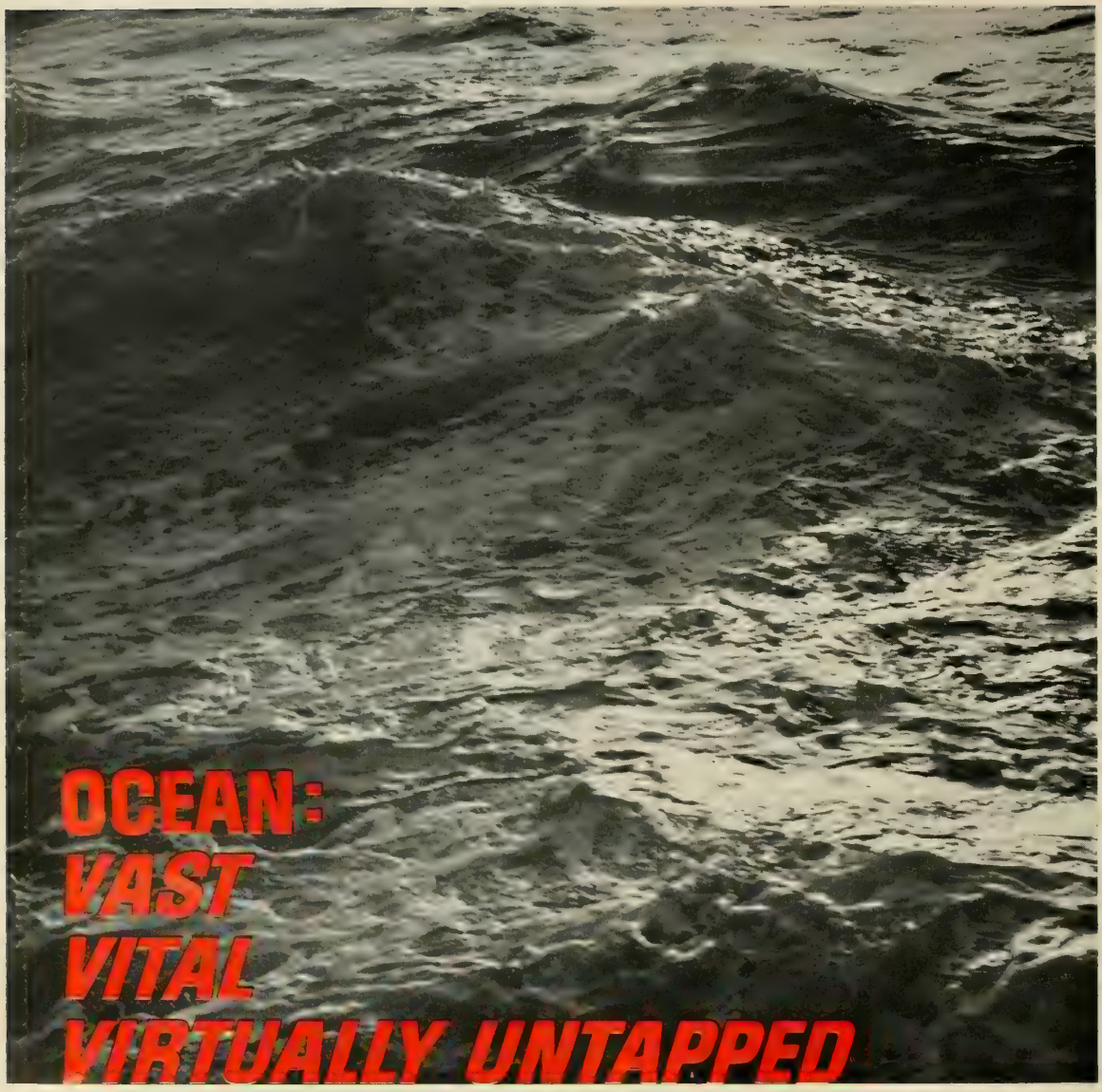

Almost as unexplored as the regions above the earth's atmosphere, the world of *inner* space is vitally important to man's future—scientific, economic, military. A pioneer in undersea technology, Aerojet-General has focused unremitting attention on the sea and its potential for more than a decade.

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The Countdown

WASHINGTON

More Confidence in Centaur

NASA and Defense Department officials have given the lagging *Centaur* booster a vote of confidence by ordering the start of construction on *Centaur* pad 36-B at Cape Canaveral. Probability that the first *Centaur* launch will slip to late April means it will be nearly one year behind schedule.

Air Force White Paper

Air Force now is preparing a White Paper on its proposed space role. This will be used to support a major drive on the Hill and in the press for an expanded military space capability.

A Blackeye for Redeye

Plans for immediate production of the Army's General Dynamics/Pomona *Redeye* shoulder-fired antiaircraft missile have been cancelled. Reason: tests of the 20-lb. bazooka-type weapon have not gone well. The missile also was intended for NATO use.

British Test in Nevada

A United Kingdom nuclear device scheduled for testing soon at the Atomic Energy Commission's Nevada proving ground is a warhead for British missiles. If successful, the British will press in Washington for its standardized use by all Western powers.

Air Force Secret Satellite

The secret satellite launched by the Air Force from Vandenberg AFB on Feb. 21 (see p. 10) was a *Discoverer*-type, not a *Samos*. The service apparently has realized it is impossible to classify just one satellite. *Midas* also is expected to disappear behind the new security curtain.

Decisions Pending on Solid Boosters

NASA and Department of Defense still are mulling over three sizes of large solid boosters—120-in., 156-in. and 240-in. Outlook is that only two will be selected. With the RFP now out on the 120-in., the move may be directly to 240-in. without an intermediate step.

INDUSTRY

Republic Turns Attention to Space

Watch for a strong move by Republic Aviation into the missile/space field. Top company officials have been meeting at a Florida hideaway to re-set the firm's direction. This follows Air Force termination of portions of the F-105D interceptor contract. Most likely avenue in meeting the crisis: a drive for big returns on the $14-million Paul Moore Space Research Center dedicated last May.

New Boss for Advent

Col. Joseph W. Johnston, deputy chief of research and development, office of the Chief Signal Officer, will assume command of the U.S. Army *Advent* Management Agency at Fort Monmouth, N.J., in an Army re-shuffle. He has been nominated for promotion to brigadier general.

Bids Due on Project Fire

Eighteen firms have been invited by NASA to submit bids on the Project *Fire* spacecraft by March 12. Two of the 200-lb. research spacecraft, designed to explore re-entry heating, will be launched over the next three years. Re-entry speed will be 24,500 mph.

Bidders Conference on RIFT

Three firms have been invited to attend the *RIFT* bidders conference at Marshall Space Flight Center on March 1: General Dynamics/Astronautics, Martin Marietta Corp. and Lockheed Missile and Space Co. The winner will design and develop the nuclear rocket stage to be used for flight-testing the *NERVA* nuclear rocket engine. Proposals for *RIFT* (*Reactor-In-Flight-Test*) will be due in one month.

INTERNATIONAL

Names in the French News

Georges Fleury, chairman of SEPR, the French company which specializes in manufacture of rocket engines, has been elected chairman of the French Astronautical Society, replacing Professor Edmond Brun . . . the French government has approved the nomination of Professor Pierre Auger as chairman of the French National Center for Space Research (CNES) . . . Dean Joseph Perez, elected chairman of the International Federation of Astronautics last October, died in Paris Feb. 12 while undergoing a surgical operation. He was 72.

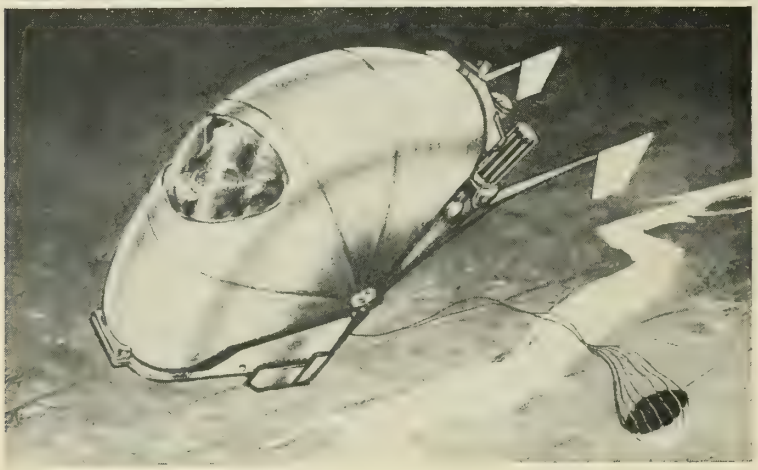
British Satellite TV Contract

Britain's General Post Office has awarded a contract to Pye Telecommunications Ltd. of Cambridge for a microwave link between Plymouth and Goonhilly Downs, where the ground station for transatlantic communications satellites is being located. Link will carry British TV programs to Goonhilly for relay to the U.S. ground station at Andover, Maine. Equipment will be suitable for 405, 525 and 625-line transmissions.

U.S. Helps U.K. IR Program

A joint Anglo-American test program for IR homing missiles has just been completed at Edwards AFB, Calif. Tests, employing a de Havilland Comet 1A flying laboratory and a B-58, were designed to measure infrared radiation from a supersonic aircraft. They were connected with the development of the de Havilland *Red Top* and *Firestreak* infrared air-to-air missiles.

Hydro-Space News



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Shots of the Week

• *Mercury Atlas-6,* with Lt. Col. John Glenn aboard the *Friendship 7* capsule, was launched from Cape Canaveral at 9:47 a.m. Feb. 20 and recovered after three earth orbits. (See special report beginning on p. 13.)

• A secret satellite was launched into orbit by the Air Force from Vandenberg AFB on Feb. 21.

Powered by a *Thor-Agena B* booster, the satellite carried a number of classified components. No other information was released.

• Earlier in the week, an AF *Minuteman* ICBM was launched from its silo at Cape Canaveral and arched some 3900 miles down the Atlantic Missile Range. It was the fifth successful silo test of the solid-fueled missile.

• An operational training launch of an *Atlas* ICBM was made from a "coffin" silo at Vandenberg AFB on Feb. 16.

• A *Pershing* missile was launched Feb. 19 from Cape Canaveral in a rigorous test of its inertial guidance system.

Preplanned pitch and yaw maneuvers were introduced to test the guidance system's ability to bring the missile back on course.

Although exact range of the flight was not disclosed, the Army said the firing exceeded the range of the 200-mile *Redstone,* and went farther than any previous *Pershing* launch.

Army Shakeup Approved

The most drastic shakeup of the Army since the reorganization of 1953 will move ahead with the tacit approval of Congress.

Failure of the House and Senate Armed Services Committees to object to the Army's plan by midnight, Feb. 16, in effect constituted official endorsement.

The plan proposes to:

—Create a Materiel Development and Logistic Command which would assume the development, procurement and supply functions now performed by six of the seven technical services.

Circle No. 12 on Subscriber Service Card

—Assign virtually all of the Army's training function to the U.S. Continental Army Command, including training of individuals and units of the technical services as well as the Combat Arms.

—Establish an Army Combat Developments Command to develop future organizational, operational and material requirements.

Patterned to a large extent after the recent Air Force reorganization, the Army plan apparently was initiated at the insistence of Secretary of Defense McNamara.

With the official go-ahead from Congress, the Army plans to devote the next 3-6 months to final organizational details of the new commands.

Commanders are expected to be named for the Materiel and Combat Development Commands in the near future, to ensure that the planned 18-month reorganization is effected without disruption.

MA-6 Miscellany

Soviet Premier Khrushchev conveyed "hearty congratulations" to President Kennedy and best wishes to Lt. Col. John Glenn for the successful *MA-6* flight. Glenn also received greetings from Soviet Cosmonauts Yuri Gagarin and Gherman Titov.

At the same time, the Russian Premier proposed that the United States and Russia pool their efforts for future space exploration.

Such an effort, Khrushchev declared, would be acclaimed "by all peoples who would like to see scientific achievements benefit man and not be used for 'cold war' purposes and the Arms Race."

President Kennedy, at his news conference last week, said he regarded the Soviet leader's proposal as "most encouraging".

Amplifying on this in reply to a question from a newsman, the President said that "when men reach beyond this planet they should leave their national differences behind them."

—John Glenn confirmed Cosmonaut Gagarin's contention that, while in orbit, he could see plowed fields on earth a hundred miles below.

Glenn said he had been able to pick out irrigating ditches and fields near El Centro, Calif., due to the contrast with the desert background.

—Perth, Australia, made certain Astronaut Glenn would be able to see the city by turning on every light in the town and using every conceivable reflecting surface, including bed sheets, for illumination.

—As the *MA-6* capsule touched the water of the Atlantic Ocean, it signalled the go-ahead for 300 post offices across the country to begin issuing a special commemorative stamp hailing the orbital shot.

The blue-and-yellow four-cent stamp had been secretly printed and distributed prior to the Astronaut's flight.

—Scientists are anxious to question Glenn about the "little luminous particles" he reported seeing at sunrise from his space capsule.

The Astronaut also reported a bright band of orange and blue light above the horizon at sunset. The band, he said, appeared to persist for a considerable period after the sun went down.

S-16 Launch Tuesday

NASA's *Orbiting Solar Observatory* is scheduled for launch Feb. 27 from Cape Canaveral. The 440-lb. spacecraft will be put in a 300-nautical-mile circular orbit by a three-stage *Delta* booster.

The *S-16* satellite—designed for six-months operation—is expected to provide the first comprehensive study of the sun and its periodic violent eruptions.

The first of a series of *OSO* vehicles, *S-16* carries 13 different experiments which depend largely on a pointing accuracy of about one min. of arc.

The *OSO* program—designed to study the sun over an entire 11-year solar cycle—is expected to cost about $85 million through 1966.

S-17 (OSO-2) is scheduled for launch in October with similar vehicles scheduled periodically throughout 1963. *S-67*—an advanced *OSO* weighing over 700 lbs.—will be ready in 1964. In all, some 15-18 vehicles may be used in the *OSO* program.

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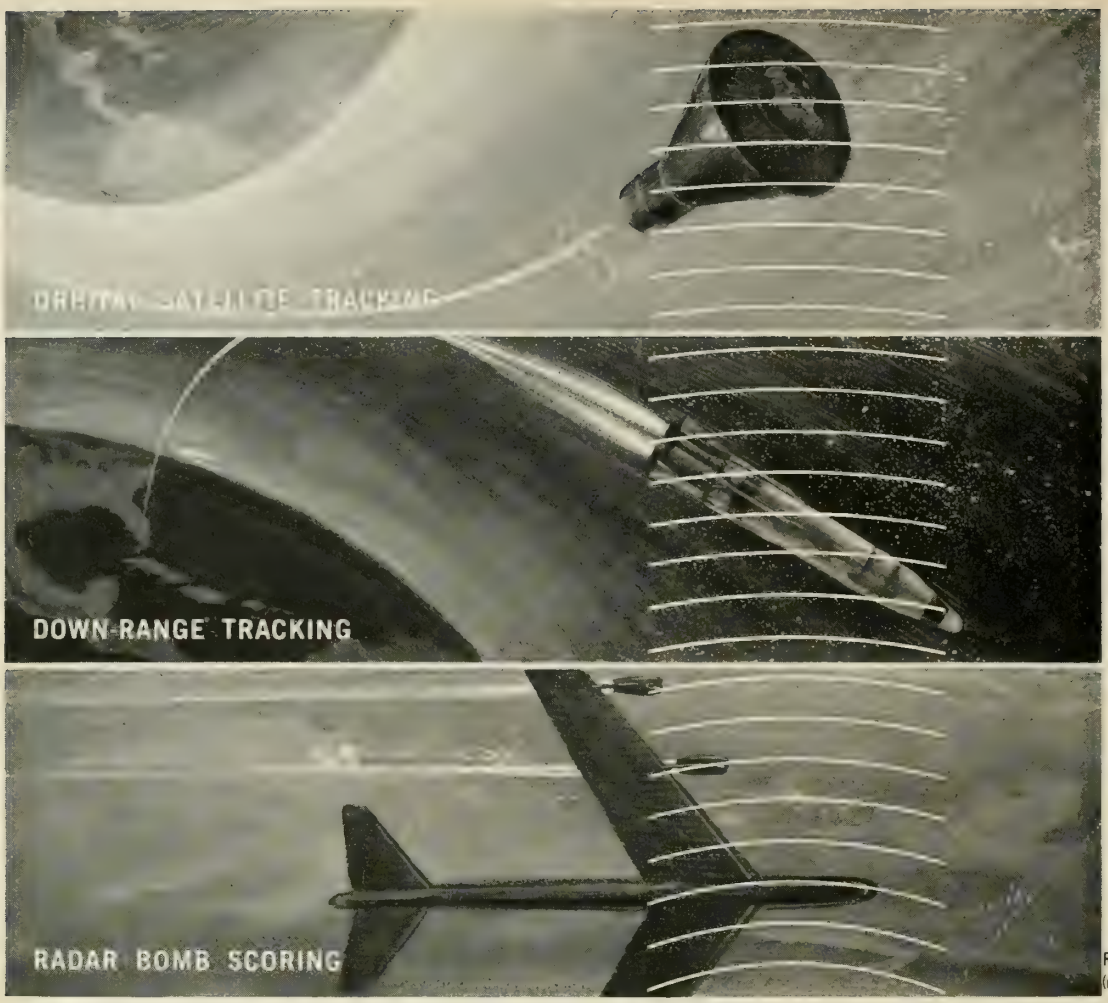

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Special Report

MA-6 Speeds Spaceflight Plans

At least five or six more manned shots likely before 18-orbit series; officials laud '100% success'

by Hal Taylor

CAPE CANAVERAL—Marine Lt. Col. John H. Glenn's successful three-orbit flight around the earth in the *MA-6 Mercury* space capsule on Feb. 20 is bringing an immediate step-up in the U.S. manned spaceflight program.

An additional five or six three-orbit manned flights now will be attempted.

That is the word from D. Brainerd Holmes, director of NASA's Office of Manned Space Flight, who told MISSILES AND ROCKETS the new flights will be attempted at two-month intervals.

"*MA-7* will go as soon as we feel we are ready," he said.

Holmes estimated that "five or six" such flights will be made before the series ends with the first of NASA's planned 18-orbit flights using a modified McDonnell capsule.

He also confirmed an M/R report (Jan. 29, p. 18) that the first 18-orbit flight—previously scheduled for this year—is slipping into 1963.

Earlier, NASA had said only four orbital flights would be attempted in 1962. In addition, it was indicated that if the first two were successful the other three-orbit flights might be dropped.

That schedule now has been accelerated. Holmes' two-month scheduling does not take into account technical and weather delays which historically have forced three-month breaks between Project *Mercury* shots.

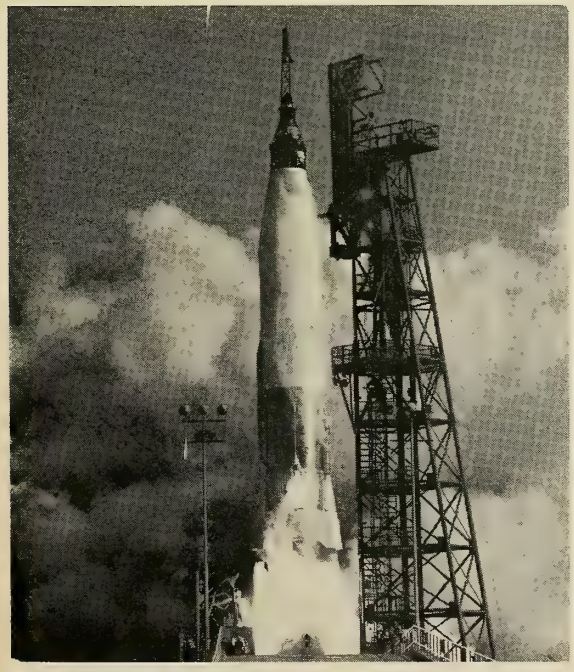
Holmes, however, is the boss of manned space programs. Other NASA officials refused to deny or take issue with the new schedule.

The additional flights, Holmes said, are needed for further astronaut training, new medical tests and checkout of possible new equipment such as attitude control and communications.

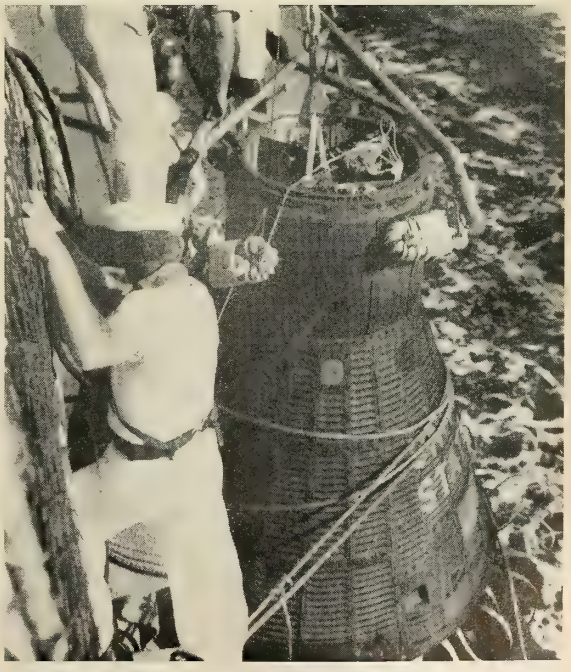
He lauded Project *Mercury* as "a good engineering program."

• **Man upgraded** — His comments came shortly after Astronaut Glenn made his historic three orbits of the earth in the spacecraft *Friendship 7*, becoming the first American and the third man to make a successful orbital flight.

Russia's Yuri Gagarin completed a one-orbit flight on April 12, 1961, while Soviet Cosmonaut Gherman Titov achieved 17 orbits last August 6.



GLENN BEGAN 4-hr., 56-min. trip at 9:47 a.m., when Atlas booster lifted off in perfect ascent with Friendship capsule.



SHORTLY AFTER 3 p.m., capsule was hauled aboard USS Noa. Earlier, Glenn described re-entry heat as "a real fireball."

Glenn's flight gave a tremendous boost to the U.S. manned spaceflight program. Of major significance: it's proof that man can achieve in space what instruments alone cannot. It was clear after the flight that the full three-orbital mission could not have been completed without Glenn at the controls of *Friendship 7*.

This drew the comment from Walter C. Williams, assistant director of the Manned Spacecraft Center, that "We not only put a U.S. man into space but we also very definitely showed how man could perform in space."

• **Lucky eleventh** — The long-delayed liftoff of *Friendship 7* from the pad at Cape Canaveral came at 9:47 a.m. EST. The spacecraft touched down in the Atlantic Ocean 166 mi. east of Grand Turk Island in the Bahamas at 2:43 p.m., 4 hrs. 56 min. 26 sec. later.

With Glenn still aboard and in "excellent condition," the spacecraft was fished from the water by the destroyer Noa 21 min. later. The astronaut was transferred to the aircraft carrier Randolph and then to Grand Turk for a medical examination.

The successful *MA-6* launch came after 10 weather or technical postponements since mid-January. Plagued for almost a week by bad weather in the Atlantic rescue areas, it finally lifted from the pad following four minor technical holds during the countdown.

A transponder in the *Atlas* guidance system and a faulty microphone in Glenn's helmet had to be replaced. Later, a power loss stopped the Bermuda tracking station's computers and a broken bolt had to be replaced in the capsule's hatch.

On lift-off, the General Dynamics/Astronautics *Atlas D* booster functioned perfectly. North American Aviation's two Rocketdyne main booster engines generated 150,000 lbs. each, with the sustainer providing an additional 60,000 lbs. thrust. The General Electric/Burroughs guidance system set *MA-6* squarely on course for orbital injection at a velocity of 25,728 ft./sec.

During the flight, Glenn's capsule reached a top speed of 17,545 mph. Each orbit lasted 88.29 min. with a perigee of 86.4 n. mi. and an apogee of 141.2 n. mi. Its inclination was 32.54°.

The flight covered some 81,000 mi. and subjected Glenn to 8 g's acceleration twice during launch and a little over that figure during re-entry.

Performance included first extended manned control of a spacecraft's attitude in orbit. Much new information of value to space medicine was obtained (see p. 16).

• **U.S. 'first'** — Glenn's extensive manual control of the spacecraft was an unexpected development of the flight. He used the so-called "fly-by-wire" setup, in which the pilot moves the control handle to electrically operate valves in the system. The valves control the hydrogen-peroxide jets which provide the reaction thrust necessary to shift the attitude of the spacecraft in yaw, roll and pitch. Backup to this is an all-mechanical linkage system.

The American Astronaut's use of the manual system was hailed as an achievement unmatched by the Soviet Union. The Russians have indicated, however, that Titov did control the attitude of his spacecraft manually.

• **Malfunctions** — NASA officials lauded the *Friendship 7* flight as perfect—"a 100 percent success." But there are at least two technical malfunctions which will be investigated closely during the remaining three-orbit flights:

—*Automatic attitude control system*—As described by Glenn, the difficulty cropped up in this system as the first orbit was almost complete. It began as the spacecraft passed over the Guaymas, Mex., tracking station. The capsule appeared to drift off in yaw to the right at about one-degree per second. After hitting the 20-degree point, it went into orientation mode and returned to zero. It was at this point that Glenn went to "manual" control.

In the automatic system, gyroscopes govern attitude of the capsule. There are four jets for the roll axis, four for pitch, four for yaw. Two jets of each set of four have a thrust of only one lb.; the others each produce a 24-lb. thrust. The small jets are designed for minor corrections, the larger jets for control of more violent attitude changes. With the small jets malfunctioning on the Glenn flight, the large jets were cutting in automatically when the capsule drifted to preset limits, thereby increasing the consumption of hydrogen-peroxide.

According to Williams, the malfunction encountered by Glenn was similar to that which occurred on the roll jets during the second orbit of the *MA-5* flight last Nov. 29, with the chimpanzee Enos aboard. It was necessary to abort that mission after two orbits.

The "fly-by-wire" system is not the full manual system, since it still connects electronically to the same jets used in the completely automatic system. But, by exercising manual control of the electronic system, Glenn was able to reduce the excess hydrogen-peroxide consumption—signalled by a red fuel-warning light as well as the yawing of the spacecraft to both left and right.

Late in the flight, Glenn switched to the full manual system which uses a set of six different jets, two for each axis.

NASA officials were unable to determine immediately the cause of the problem. One suggested a loose connection might be responsible.

—*Heat shield* — Prior to re-entry, there was a telemetry indication that the heat shield was separating prematurely from the capsule, which could have resulted in a final searing catastrophe for Astronaut Glenn and the *Friendship 7*. To guard against this, the retropack was retained with the thought that its straps would hold the shield in place until they melted. By then, it was estimated, atmospheric pressure might be sufficient to hold the shield in place.

The fears were unnecessary. Following close examination of the capsule, NASA reported that the shield did not separate from the capsule until main chute deployment, as scheduled—leaving a faulty telemetry signal from a microswitch as the probable villain.

• **Egress** — One final problem cropped up when Glenn was unable to leave the spacecraft through its neck. This is the planned exit-route from the capsule for a water landing. Following about 20 min. of effort while the capsule was on the Noa's deck, Glenn gave up and blew the explosive hatch. During all this, he suffered his only apparent injury of the flight—a pair of skinned knuckles. ⁂

Spaceflight Score Box

DATE	GLENN FEB. 20, 1962	TITOV AUG. 6, 1961	GAGARIN APR. 12, 1961
TYPE SHOT	Orbital	Orbital	Orbital
NUMBER OF ORBITS	3	17	1
NAME OF CRAFT	Friendship 7	Vostok II	Vostok I
APOGEE/PERIGEE (mi.)	162 99	159.3/110.3	187.75/110
DISTANCE (miles)	81,000	434,960	25,000
TOP SPEED (mph)	17,545	17,750	17,400
FLIGHT TIME	4 hrs. 56 min.	25 hrs. 18 min.	108 min.
CRAFT WEIGHT (lbs.)	4200	10,430	10,460
ROCKET THRUST (lbs.)	360,000	800,000	800,000
WEIGHTLESSNESS	4 hrs. 45 min.	24 hrs. 59 min.	89.1 min.

Special Report

Excerpts from Message Transcript

(This edited transcript of conversation between Astronaut John H. Glenn Jr. and Project *Mercury* ground stations is compiled from MISSILES AND ROCKETS recordings, wire service reports and the unofficial NASA transcript.)

Glenn: Five-four-three-two-one-zero. Liftoff. The clock is operating. We are under way.

Cape: Roger, read you loud and clear. We are programing it, all okay.

Glenn: It is bumpy along about here.

Cape: Roger. Stand by for twenty seconds.

Glenn: Roger.

Cape: Three-two-one. Mark.

Glenn: Roger. Back-up clock is started. Fuel 102,101. Oxygen 78, 100. Amps 27.

Cape: Roger, loud and clear. Flight path is good.

Glenn: Roger, checks okay. Minus 7 on your mark. Some vibration area coming up now . . . Coming into high Q a little bit. A little contrail went by the window, or something there.

Cape: Roger.

Glenn: Fuel 102, 101. Oxygen 78, 101. Amps 24. Still okay. We're smoothing out some now, getting out of the vibration area.

Cape: Roger. You feeling max Q?

Glenn: Flight path is very good. Pitch 43. Cabin pressure coming down 57. Okay. Very smooth now.

Cape: Roger. Flight path is good.

Glenn: Cabin pressure is holding at 61. Have had some oscillations, but they seem to be damping . . . Two minutes. Fuel is 102, 101. Oxygen 78, 102. G's are building to six.

Cape: Roger. Reading you loud and clear. Flight path looks good. Pitch 25. Stand by for staging.

Glenn: Roger. Beco. Beco. (booster engine cut-off). I could see the tower go. I saw the smoke go by the window.

Cape: Roger. We confirm staging TM (telemetry).

Glenn: Roger. I still have about one and a half G's. The tower went right then. I have the tower in sight way out.

Cape: We confirm . . . Tower is green.

Glenn: Roger. One and a half G's.

Cape: Roger, seven, Still reading you loud and clear. Flight path looks good.

Glenn: Auto retro jettison is off; emergency retro jettison fuse switch off and retro jettison fuse switch off.

Cape: Flight path looks good.

Glenn: Roger. Understand everything looks good. G's starting to build up a little bit . . . Roger, Bermuda, stand by. This is *Friendship 7*. Fuel 103, 101. Oxygen 78, 100. All voltages above 25. Amps 26.

Cape: Roger. Still reading you loud and clear. Flight path is very good. Pitch minus three.

Glenn: Roger. Check that. Minus seven on your minus three.

Cape: Seven.

Glenn: *Friendship 7*, fuel 103, 101. Oxygen 78, 100. Amps 25. Cabin pressure holding at 58.

Cape: Cape is go. We're standing by for you.

Glenn: Cape is go and I am go. Capsule is in good shape.

Cape: Roger, all systems go, seven.

Glenn: Oxygen 78, 100. Cabin pressure holding steady at 58. Amps is 26. All systems are go.

Cape: Roger. Twenty seconds to Seco (sustainer engine cut-off).

Glenn: Roger.

Cape: Flight path looks very good. Ten seconds.

Glenn: Seco. Fired okay.

Cape: Roger. Stand by.

Glenn: Zero G and I feel fine. Capsule is turning around. Oh, the view is tremendous.

Cape: Roger. Turnabout has started.

Glenn: Capsule turning around and I can see the booster doing turnarounds just a couple of hundred yards behind me. It looks beautiful.

Cape: Roger, seven. You have a go of at least seven orbits.

Glenn: Understand go for at least seven orbits. This is *Friendship 7*. Can see clear back a big cloud pattern way back across toward the Cape. Beautiful sight.

Woomera: *Friendship 7*, we read you. Go ahead.

Glenn: This is *Friendship 7*. I had a lot of cloud cover coming off of Africa. It has thinned out considerably now and, although I can't definitely see the ocean, there's a lot of moonlight here that does reflect off what clouds there are.

Woomera: Shortly you may observe the lights down there. You ought to make a check on that to your right.

Glenn: Roger. I'm all set to see if I can't get 'em in sight.

Woomera: Are there symptoms of vertigo or nausea at all?

Glenn: Negative. No symptoms whatsoever. I feel fine . . . That was about the shortest day I've ever run into.

Woomera: Time passes rapidly, eh?

Glenn: Yes, sir . . . I have Pleiades in sight very clear. Picking up some of these star patterns now a little better than I was just off Africa.

Woomera: Have you sighted Orion yet?

Glenn: Negative. Do not have Orion in sight yet.

Woomera: Standing by for your blood pressure whenever you tell me.

Glenn: I'm already sending it. Do they pick it up?

Woomera: Roger. You are in good shape.

Glenn: I do have a light on the ground . . . Just to my right I can see a big pattern of lights, apparently right on the coast. I can see the outline of a town and a very bright light just to the south of it.

Woomera: That is Perth and Rockingham you're seeing there.

Glenn: The lights show up very well. Thank everybody for turning them on.

Woomera: We have your blood pressure now. It reads 126 over 90. Let's have the results of your physiologic tests.

Glenn: I have had no ill effects at all as yet from any zero G. It's pleasant, in fact. Visual acuity is still excellent. No astigmatic effects. My head movements cause no nausea or discomfort whatsoever.

Cape: Would you give us the difficulty you were having in the yaw?

Glenn: It just started as I got to Guaymas and it appears to drift off to the right about one degree per second. It would go over to an attitude of about 20 degrees, then hold, and then when it hits at about a 20-degree point it then goes back into orientation mode and comes back to zero and it was cycling back and forth in that mode. I am on fly-by-wire now. I am controlling manually. Over.

Cape: Roger. Understand.

Glenn: What appears to have happened is I believe I have one pound thrust in left yaw, so it drifts over out of limits and then hits it with the high thrust.

Cape: *Friendship 7*, we concur here. Recommend you remain fly-by-wire.

Glenn: Roger. Am remaining fly-by-wire.

Special Report

First Checks Show No Apparent Ill Effects

by Heather M. David

CAPE CANAVERAL—The nausea that plagued Cosmonaut Gherman Titov seemed to be no problem for American astronaut John Glenn. However, U.S. space medics took no chances that he would be caught unprepared.

Along with other emergency medical supplies, Col. Glenn's capsule carried several ampules and tablets of drugs to counteract motion sickness. He also carried a mild sedative and a mild stimulant.

The special injectors, called "Astro-Pens," were designed and made by the Rodana Research Corp., Bethesda, Md.

The problem of nausea during spaceflight is one of great concern to bioastronautics experts in the United States. Not only is it uncomfortable or even debilitating, it is a signal that some stress is registering an unusual effect on the balance mechanisms—the organs of the inner ear.

These effects also may manifest themselves in dangerous visual illusions. In other words, the astronaut may "see things" during accelerations or weightlessness. This could affect his ability as a pilot.

During their lengthy preparation for *MA-6*, *Mercury* Astronauts John Glenn and back-up pilot Scott Carpenter visited the Naval School of Aviation Medicine at Pensacola, Fla. Here they were indoctrinated in two simple tests they could perform aloft. Results of these tests will help determine what the effects of weightlessness are on man's balance mechanisms.

In one test, the astronaut was to look steadily as a small light in his otherwise darkened cockpit. Under some conditions of acceleration, such a light will appear to suddenly "take off" in a random fashion. If it remained still, it may mean that visual illusions which have caused many airplane crashes may not occur during weightlessness.

Another illusion for which the astronaut was to test is one which occurs normally during angular accelerations. This effect, a source of airplane accidents, makes objects appear to move. In a smoothly moving aircraft, it will occur at .2°/sec^2. However, since it may have been difficult to create a smooth angular acceleration in the *Mercury* spacecraft, it may not occur until about 2°/sec^2.

The astronaut also did some head-turning exercises to see if they might cause nausea. In his case, they didn't.

Glenn consumed with no difficulty the tubes of food and water and malted milk tablets specially prepared for dining in weightlessness.

Officials declined to try to explain why Titov suffered "space sickness" and Glenn did not. But they pointed out that Titov apparently became sick after six hours of weightlessness.

• **Biomedical results** — Quick-look data showed that Glenn suffered no unusual changes in blood pressure, heart rate, respiration or temperature during weightlessness. Although his pulse increased by a factor of a little less than one-half during launch, physicians said it leveled off after some 20 minutes of weightlessness. They added they did not consider this abnormal.

SENSORS are attached to Glenn's torso prior to MA-6 launching. Officials reported the devices transmitted "superbly."

The sensing system itself worked "superbly." NASA said it will take about two weeks to reduce and interpret all the information it transmitted.

Had anything gone wrong, Glenn had probably the world's most illustrious medical team at his disposal. In addition to emergency rescue teams at the launch site, in the Bahamas, Hawaii, Bermuda and the Azores, a star-studded team of specialists was on call for consultation.

These specialists, headed by USAF Medical Corps Brig. Gen. James W. Humphreys, had a jet ready to transport any one or number of them if the call came from astronaut's personal physician, Dr. William K. Douglas.

The crack medical team included an orthopedic surgeon, a plastic surgeon, a pathologist, a radiologist, an anesthesiologist, an internist and a genitourologist.

The medical stations set up at the launch site and tracking stations had complete base-line data on Glenn (and Carpenter) and followed his medical progress. They also had some 30 pints of blood cross-matched with Glenn's.

The Air Force had 63 pararescue men trained as SCUBA (self-contained underwater breathing apparatus) divers to rescue the astronaut had he been plunged into the ocean and injured.

• **Space suit**—The *Mercury* spacesuit and internal cooling system paid its way when cabin temperature hit 108°F. Glenn "stayed real cool," as one official put it, as his suit stayed more than 20° cooler than the cabin.

The contract for space suits to be used in Projects *Gemini* and *Apollo* is expected to be announced soon.

Industry officials at Cape Canaveral for the flight said that the research and development award for the suit appears "imminent." Firms were invited to submit proposals on the contract last December.

While the officials refused to comment on the contract specifications, those interviewed indicated that their firms were thinking in terms of form-fitting suits.

They said that radiation shielding—and resulting cumbersome suits—will not be needed except during solar flare periods.

It is probable, they added, that a device will be used to warn astronauts of solar flares so that they can get under cover. The main problem for the follow-on suits, they said, is a thermal one.

A special thermal control system will be needed to remove excess heat generated by the astronaut's body and protect him from the heat and cold of space. ⁂

Special Report

Tracking Net Faces Major Build-up

BIG CHANGES are in the works for the *Mercury* Tracking Network as NASA now turns its attention to upcoming 18-orbit and Project *Gemini* manned spaceflights.

Gemini, the two-man space program, will require from three to five new stations. The 18-orbit flights scheduled for early next year call for no new stations, but major changes in communication and radar facilities will be made.

The new requirements dwarf the subtle innovations made in the 18-station network between *Mercury* unmanned orbital flight series and *MA-6*.

These included:

—Addition of more instrumentation to station consoles for the registering and readout of more information about flight systems, attitude and fuel consumption.

—One new man added to each station to head up a staff which includes a capsule communicator, a flight surgeon, and a capsule engineer and systems monitor.

—An eight-channel pin recorder added to record additional information on position and acceleration.

—A new voice circuit to the Canary Islands.

—Moving the Atlantic Ocean ship 2000 miles down off the coast of Africa.

After the successful tests during *MA-6*, space agency officials are now ready to make major changes in the network for the follow-on flight programs.

• **Eighteen-orbit series**—These flights, to last some 24 hours, will require more powerful communications and radar equipment.

Each station will be supplied with a 3200-mile communication kit. Current equipment ranges from 500 to 1000 miles. The FPS-16 instrumentation radar sites will be increased in both range and receiver sensitivity.

A bidders conference will be called and a contract awarded for the new radar facilities within three months. Station telemetry capability will also be updated.

In addition, the Atlantic Tracking Ship will be moved to the Pacific, and the Indian Ocean ship will be moved over closer to Africa.

DONALD K. SLAYTON, tabbed as next orbiting astronaut, watches Dr. W. K. Douglas, astronaut physician (left), and Astronaut Alan Shepard at Mercury Control Center.

• **Project Gemini** — A NASA official here reports that a final decision on *Gemini* tracking requirements will not be made for six to eight months. The time lag arises from the need for the State Department to complete negotiations for new foreign station sites and from the requirement to complete research and development work.

The official said that three to five new stations will probably be needed.

Gemini's tracking problems stem from its orbital rendezvous missions and the fact that its telemetry requirements are twice those of *Mercury* because the spacecraft will have two pilots.

As a result, the official said, the current FM systems probably won't work. Instead, a pulse code modulation (PCM) system will likely replace it.

NASA will purchase one PCM station and then evaluate it before making a final decision.

• **Massive volume** — The *Mercury* Tracking Network is under the control and supervision of Goddard Space Flight Center. Eighteen stations around the world transmit massive amounts of information on each *Mercury* flight by voice, teleprinter, and voice to GSFC and the *Mercury* control center at Cape Canaveral.

Radio Corporation of America maintains and operates the Cape control center's instrumentation and communications, and Western Electric Co. was in charge of installing the worldwide network of tracking stations.

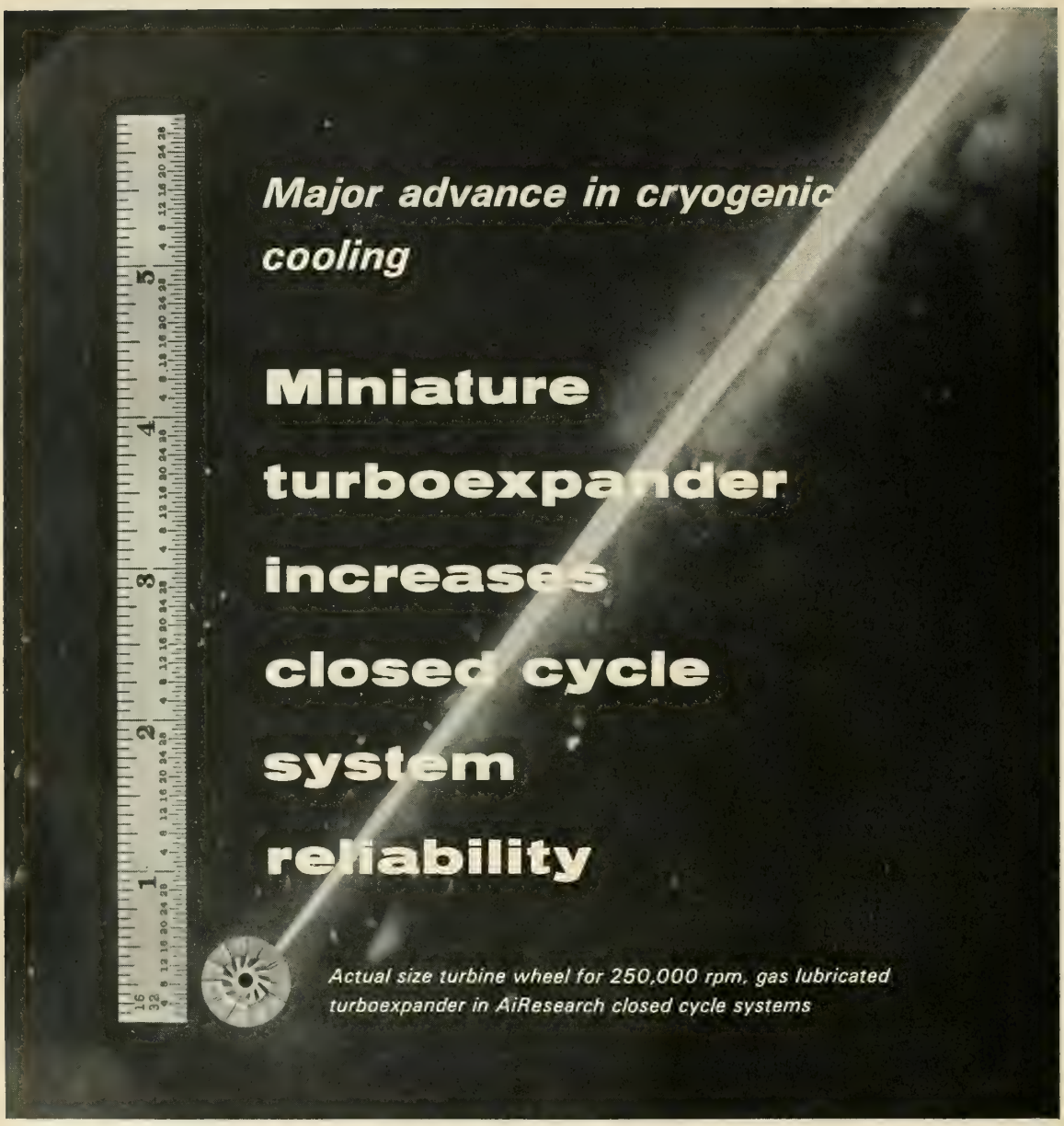
Tracking sites on the North American continent include: Guaymas, Mex.; Point Arguello, Calif.; Corpus Christi, Tex.; White Sands, N.M.; Eglin Air Force Base, Fla.; and Cape Canaveral. These are linked to Goddard by land line.

The overseas sites include: Bermuda; Canary Is.; Kano, Nigeria; Zanzibar; Atlantic Ship; Indian Ocean Ship; Muchea, Australia; Woomera, Australia; Canton Is.; and Kauai Is., Hawaii. These are linked to Goddard by a combination of cable and radio telecommunications.

The radio teleprinter facilities use single-sideband transmitters, less susceptible to atmospheric interference.

Submarine cables to London (via New York), to Hawaii (via San Francisco) and to Australia (via Vancouver, British Columbia) were chosen because they can be expected to give higher reliability on east-west paths that have had a rather poor radio performance history.

The Australian cable is used during actual mission times only. ⁂


Major advance in cryogenic cooling
Miniature turboexpander increases closed cycle system reliability
Actual size turbine wheel for 250,000 rpm, gas lubricated turboexpander in AiResearch closed cycle systems

Garrett-AiResearch is completing development work on closed cycle nitrogen, helium and neon systems using a tiny turboexpander in place of a piston expander.

This promises to dramatically increase system reliability and service life because all wearing surfaces, valves and troublesome reciprocating loads have been eliminated.

These compact, lightweight systems for masers, parametric amplifiers, IR cell cooling and computer components are ideally suited to commercial applications as well as military ground and aerospace uses.

AiResearch was first in production with an open cycle IR cooling system, and has already produced a closed cycle nitrogen system. The company is now working on military programs for 30°K and 4.2°K closed cycle systems.

Utilizing its experience as a world leader in lightweight turbomachinery and cryogenic cooling, AiResearch is also developing an all-turbomachinery closed cycle system incorporating a turbocompressor as well as turboexpander.

Your inquiries are invited.

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echnical Countdown

ELECTRO-OPTICS

per Fast Camera To Be Shown

Electro-Optical Instruments, Inc., this week will demonate what it believes is the "world's fastest" framing camera. signed principally for action-recording of various phemena such as arc and plasma gas discharge, explosive tonations and hypervelocity impacts, the KSC-600 camera ll be shown to the press in a performance which will clude filming of an exploding bridgewire. The camera, velopers say, is capable of taking six frames in line at a te of 10^8 frames/sec. Exposure time can be as low as 5 noseconds.

olar Concentrators Can Cut Costs

The use of optical focusing configurations for solar ergy concentration in the generation of electricity offers tal system cost savings of up to 30% over unassisted photoltaic systems. A report of a recent Air Force study indiates that such savings are possible using today's techniques, nd would include launch costs of approximately $500/lb. he study represents phase 1 in a program by Electro-)ptical Systems, Inc., to evaluate use of light concentration ith photovoltaic power generators. It included an analysis f silicon solar-cell generators in the power range of from 00 to 1500 watts. Optimum concentration ratio was deermined to be 2.5.

ELECTRONICS

Nuclear Environment Computer Developed

An advanced space computer capable of withstanding severe radiation environments is being developed by IBM in Owego, N.Y. Only bread-boarded now, the finished prototype is expected to occupy less than 2 cu. ft. Under development since 1956 for the Air Force, the 100-lb. system should be ready for operational use by the mid-1960's, the company says. It will operate on about 150 watts.

Low-Cost, Rapid Response Tracker Built

A radically new control device, called a "ball tracker," has been developed by Hughes Aircraft for military operators to use in centering tracking pips on a radar screen over an existing target pip. The electromechanical actuator is a Bakelite sphere protruding from the operator's control box. Because the x and y outputs are at right angles on the ball, control combinations are infinite and tracking response is very smooth. Only light fingertip control is required to move the tracking pip in any geometric pattern. Developers say the device should yield savings of up to $2000/unit compared to former tracking methods.

Fuel Cell Used For O_2 Measurement

Dangerously low or high levels of oxygen in a spacecraft could be detected with the same techniques employed in fuel cells. General Electric engineers have used a small hydrogen-oxygen fuel cell as a self-powered sensor. It is simple in design, and output signals (in milliamps) are relatively high. A ⅝-in.-dia. ion-exchange membrane between two catalytic-platinum electrodes is used in one experimental model. (The H_2 side uses platinum black and teflon; the O_2 side electrode is a fine-mesh platinum screen.) The complete 4.5 x 1.5-in.-dia. cylinder weighs less than 7 oz. and requires only a 45-cu.-in. hydrogen supply under 500 psi pressure for up to 30 days continuous operation.

ADVANCED MATERIALS

Filament-Wound Thrust Chamber Studied

An ablative-cooled thrust chamber will be fabricated by United Technology Corp. for NASA evaluation. The filament-wound structures were developed by UTC for extended firing applications. A flightweight unit developing 2200 lbs. thrust has been continuously fired for 4.5 minutes. The chamber is aimed at space and upper-stage applications because of its high thrust-to-weight ratio and simplicity. It also has a potential in small weapons.

Silver Heat Resistance Increased

The addition of finely-powdered aluminum oxide to pure silver increases the metal's heat resistance to 1400°C—some 550° above its melting point. Scientists at Martin Marietta's Research Institute for Advanced Study have found that the silver alloy can support light loads at 1100°C. Experiments indicate that oxygen has a role, since alloy specimens heated in inert atmosphere resulted in a loss of silver.

Deadweight Machine Under Construction

Accurate determination of hysterisis in force transducers will be possible with a 100,000-lb. capacity dead-weight machine being built at the Orbitran Co. Designed primarily to calibrate dynamic electronic weighing systems, the unit has special hydraulic handling equipment capable of continuous high-speed loading in either direction. Weight calibration will be traceable to the Natonal Bureau of Standards.

SPACE MEDICINE

Physiological Hazards Study Funded

The University of California has copped a prize NASA grant to assess the physiological hazards of extended space flight. The award, worth $590,000 for four years, will cover development of techniques and instruments and will later include an animal spaceflight program. Research will be conducted by the University's new Space Biophysics Task Group.

NEMA Attacking Wire & Cable Snarl

Standardization and closer cooperation between wire and cable manufacturers and missile/space designers are being actively investigated by the High Temperature Section of the National Electrical Manufacturers Association. NEMA has proposed a standard expected to serve as a uniform reference for future military and commercial specifications of high-temperature insulated wire and cable. The standardization problem (M/R, March 27, 1961) is still complex, expensive and confusing, and NEMA has some internal inertia to overcome. Several of its members are confident of their ability to gear up in an emergency at least as quickly as they did in World War II and the Korean conflict.

Aerojet Capability Breeds Success

Huge booster firing, expansion into Florida are most recent evidence of firm's steady prosperity

by Willard E. Wilks

"WE'VE GOT 9000 people with degrees and 20 years experience in the rocket business. How're you going to beat that?"

Aerojet-General Corp. President Dan A. Kimball, relaxing with a cigar in his suite at Los Angeles' Jonathan Club, was contemplating his firm's future. The former Navy secretary had good reason for his confidence.

That future looked particularly bright last week with the successful firing on Feb. 17 of Aerojet's 600,000-lb.-thrust segmented solid booster (see box). The motor is the third solid developing over 500,000 lbs. thrust fired by the company in the past eight months.

It was a giant step ahead in the company's bid for the Air Force 120-in. boosters for *Titan III*. Aerojet also is shooting for contracts on the bigger 156-in. and 240-in. solid boosters on which Pentagon decisions still are pending.

Firing of the big motor at the firm's Sacramento, Calif., test facility capped two other recent successes by the still-growing rocket firm:

—It was selected by NASA last month to design and develop the 1,200,000-lb.-thrust liquid hydrogen M-1 engine which will power the second stage of the *Nova* launch vehicle. This contract, which calls for the engine to be ready for operational use in 1965, is expected to total $90 million.

—After completing six months' work on the first phase of the *NERVA* nuclear rocket under a NASA-Atomic Energy Commission contract, Aerojet received a follow-on five-year, $26.6-million contract from the two agencies for further *NERVA* development.

• **Crossing continent** — This week, Aerojet is scheduled to appear before a public planning commission meeting in Florida to ask for industrial rezoning of an entire 75,000 acres in Dade County which now is under various stages of procurement.

On the site, near Homestead, Fla., Aerojet is planning its new Space Booster Plant, to be developed as both a liquid and solid facility.

"We are going to tell the public meeting we have started development already," K. F. Mundt, vice president-manufacturing, told MISSILES AND ROCKETS last week. "Ground has been broken at the southern end but at this time only road and drainage facilities for parts of the area are being put in."

The land is in one dumbbell-shaped package. The north and south ends are squares of about 35,000 acres each, connected by a neck of land two miles wide and four miles long.

CONFIDENT CONFEREES are Aerojet-General President Dan A. Kimball (left), Executive Vice President William E. Zisch (center), Board Chairman A. H. Rude.

STRIKING CONTRAST illustrates Aerojet's growth. At left is a World War II test-firing of a 25-ALD-1000-lb.-thrust chamber solid-propellant engine. At right, the successful Feb. 17 test of a 600,000-lb.-thrust motor. *(See p. 24.)*

"How fast construction goes depends on a number of things—but primarily on whether Aerojet is awarded the 120-in. segmented rocket contract," Mundt said. "If we are fortunate in obtaining the contract, we are going full out to get the facility done. A big construction program would be under way with upwards of $10-15 million being spent in the very near future for the first increment of the solid plant."

"If we are not fortunate in obtaining the 120-in., we still fully anticipate we'll receive business for bigger rockets. We therefore would slow up construction and tune it to receipt of those contracts."

While initial work on NASA's M-1 engine will be done in Sacramento, where the liquid test stands are capable of handling up to 1½ million-lbs. thrust, some later work on the project will be assigned to Florida.

When completed, the new space booster facility may well resemble Venice. An important factor in site selection was its location only a few feet above sea level.

"We plan to bring in a deep water canal so heavy rockets can be processed, tested, and shipped via water. We wouldn't have to do it for the 120-in. or the 160-in. but anything larger will need canals," Mundt explained. "Although the rocket wouldn't actually be processed while floating, it would be floated from one processing station to another."

The Florida development will be carried out under an Aerojet 20-year master plan.

"We don't want to disappoint or mislead the Florida people, but if we get the 120-in. we will employ about 2000 there within a year," Mundt said.

• **Steady boom**—Aerojet President Kimball and Executive Vice President William E. Zisch see all this as a reasonable progression in the booming growth Aerojet has enjoyed since Kimball took over leadership of the management team in 1944. That was the year General Tire paid $250,000 for 51% of Aerojet Engineering Corp., founded two years earlier by five Cal-Tech scientists who developed JATO. Today 51% of Aerojet is worth about $36 million, and General Tire, which knows a good thing, owns 84%.

From a producer of JATO bottles in World War II, Aerojet has grown to what it boasts is "the world's largest industrial organization devoted primarily to development and production of both solid and liquid rocket engines." Its liquid engines power *Titan,* stages of *Thor-Ablestar, Atlas-Able* and *Delta; Aerobee* and *Astrobee* sounding rockets, and the *Bomarc-A* booster. Its solids propel *Polaris, Sparrow III, Tartar, Skybolt, Genie* and *Hawk,* and stages of *Minuteman, Blue Scout* and *Scout.* It still does a profitable business in JATO, two models of which are the only rocket engines certificated by Federal Aviation Agency for commercial aircraft.

There was a time, in 1946, immediately following World War II, when, Kimball says "We thought, 'no more war, no more rockets.' But the Navy told us to keep the plant open. We cut down to 375 employment from a wartime payroll of 1500. The property in Azusa was owned by the Defense Plants Corp., and we bought it because we wanted to run our business ourselves."

Aerojet then began a period of growth that has brought an unbroken rise in net sales for the past 16 years, from $2.8 million in 1946 to an estimated $472 million in 1961. Net income, except for 1955, also has pushed steadily upward, from $230,506 to $11.8 million for Fiscal 1961. In the past decade, Aerojet's smallest annual sales increase was $9 million, the largest $146 million in 1959. A $61-million increase was recorded in 1960, $47 million for 1961, and the company expects to do "just as well" in 1962.

Major growth factors included large-scale production of JATO for the Air Force and Navy during the Korean War, and *Titan, Polaris,* second-stage *Minuteman* and *Skybolt* propulsion systems. *Titan,* the biggest program, has accounted for more than $300 million in sales.

Korean War business jumped Aerojet's sales from $12 million in 1950 to $23 million in 1951. With the firm developing its first large liquid facilities at Sacramento in the early 1950's, volume snowballed steadily to $69 million in 1955, and then took a big spurt to $144 million in 1956, the main boost coming from *Titan I.* Continuing upward, sales moved to $218 million in 1958, followed by another jump to $364 million in 1959 as *Minuteman, Polaris* and *Titan II* added their share. *Minuteman* accounted for about $85 million of the rise.

• **Meeting the price**—"You get it on technical competence," Kimball said. His formula for running Aerojet: "Get good technical talent and know how to sell to the government."

Kimball doesn't spare expense to obtain top scientific talent. Dr. Theodore von Karman, who founded Aerojet and now is chairman of the firm's Technical Advisory Board, received a life-time contract to stay on after General Tire acquired control.

Kimball is especially proud of the 9000 degrees Aerojet counts among its 30,000 employees. "I have no technical competence," he says. "I had to quit high school in the second year to go to work." His first job was as an electrical mechanic in a St. Louis automobile factory. In World War I, he became an

Company Sure It Can Build Million-Pounder in 14 Months

THE SUCCESSFUL FIRING by Aerojet-General of the world's largest solid booster to date has made the firm confident it can have a million-lb.-thrust unit ready for preliminary flight rating tests 14 months after it gets a contract.

The massive, 5-segment, flight-weight unit generated 600,000 lbs. thrust in a 98-second test firing Feb. 17. Approximately 107 tons of an advanced Air Force propellant produced about 50 million pound-seconds total impulse in the 100-in.-diameter motor.

Total weight of the 53-ft.-long motor was 119 tons. The ignition rocket alone generated over 50,000 lbs. thrust.

The firing was the third of a series of full-scale tests by Aerojet. The last produced a thrust of 500,000 lbs. with four segments. Test objectives fully met in the firing included an increase in action time to 98 seconds, increase in total impulse to about 50 million lb.-sec., and modification of grain design to eliminate shivers and provide a thrust-vector control device.

In addition, the chamber was stronger and lighter than previous motors and the propellant grain design was changed to provide maximum thrust immediately after ignition. The thrust then became regressively smaller in the firing. This would be necessary on a flying booster, since the weight would constantly decrease due to propellant consumption. Ignoring this effect would create excessive acceleration forces.

Aerojet is fabricating and processing a larger and more powerful motor for test-firing in the near future. Aerojet President Kimball says the firing of the current unit and the other tests during the past year amply demonstrate that large solid boosters can be developed on very short timetables—". . . despite claims of many formidable rocket experts that such a job would take much longer."

Army pilot, and then, after running out of money in Washington, D.C., while waiting for an air mail pilot's job that never materialized, he went to work for General Tire.

• **"Knowing needs"**—Kimball is essentially a salesman—"selling, that's the sparkplug"—although he picked up a good deal of business knowledge teaching tire dealers "how to make money so they wouldn't go broke so they could buy tires." He says, "A lot of people don't know how to sell to the government. If you're going to sell tires, you do it one way—if you're going to sell to Department of Defense, you do it another. It's not really a question of selling. It's a matter of knowing the needs of the various government departments—also, what you think they should want. You sell by proposal."

Although Kimball is wary of too much diversification, Aerojet has gone in for a good deal of expansion, taking up electronics, ASW, structural materials, nucleonics, automation, facilities engineering, chemistry, power equipment, ordnance, space vehicles and nuclear and electrical propulsion. It has a $19-million Navy contract to develop an antisubmarine torpedo, a $12-million contract for R&D on the *Midas* infrared subsystems, and a contract for about $5 million on the Army *SD-2* drone. It expects about $300 million on the *NERVA* program over the next five or six years.

Other contracts include $4.3 million from the Air Force for design of a fissio-chemical plant to transform common ammonia into hydrazine fuel by an atomic process, $8.2 million to develop energy conversion equipment for NASA's *SNAP 8* system, and pacts totaling about $73 million for design of test facilities for *Saturn* and *Rover*, and work on *Nike-Zeus* and Project *Press* facilities at Kwajalein.

Aerojet also is making warheads for *Hawk*, *Nike-Hercules* and *Tartar*, producing non-atomic warfare ordnance, and is constructing two test stands for nuclear rocket engines at the AEC's Nevada Test Site. In addition, it developed the prototype reactor for the world's first mobile nuclear powerplant, ML-1, under AEC-Army sponsorship.

• **Diversified as is** — "We have elected to stay pretty much 100% in the defense field," Kimball said, pointing out that Aerojet doesn't worry too much about diversification because its parent company has wide interests. "We're just dabbling at commercial-type business," he says. The dabbling includes a $2-million contract for development of an automated mail-sack sorting system for the St. Louis Union Railroad Station, another $535,000 for a similar system at Texarkana, Tex., and $835,000 for design of an advanced parcel post sorting system for a Florida post office. Aerojet also is designing automation systems for a shoe factory warehouse and developing Hydrocket, a maritime jet propulsion system, for surface craft.

"We get pushed into enough new fields without looking for them," said Kimball. "Someone tried to interest us in the computer business, but we decided 'no.' We also could have gone into the shipbuilding business. The company wouldn't have cost a dime, but we decided we'd have to take management talent and put it over there to run that. You can get your management talent spread out too far."

He believes some firms have bought too many companies, spread management talent too thin.

• **The lineup**—Aerojet recently acquired Space Electronics Corp., Glendale, Calif., which now is part of Aerojet's new Space-General Corp. subsidiary. Space-General, which will design and develop complete missile and space systems, is building a new plant on a 73-acre site near Azusa. Aerojet also recently strengthened its ASW capability with acquisition of 45% of Global Marine Exploration Co. from Union Oil of California, which retains 45%. Global Marine has conducted deep sea drilling in the Mohole project.

Aerojet is organized into 14 major product divisions, nine located at its Azusa, Calif., headquarters, including Advanced Research & Products, Oceanics, Torpedo, Avionics, Chemical, Nuclear Propulsion, Power/Equipment, Spacecraft, and Structural Materials. Other divisions include AETRON, Covina, Calif., specializing in design and construction of launching complexes; Ordnance, Aeronautics and Manufacturing, Downey, Calif., and Atlantic division, Frederick, Md., which works in automation and research in underwater communications. Facilities include the liquid and solid rocket plants at Sacramento, Calif.; Aerojet-General Nucleonics, San Ramon, Calif., and the Long Range Planning Group, Monterey, Calif.

In a statement of policy and outlook, Zisch told M/R:

"We do not have as an objective a dramatic increase in sales volume. In the field in which we're operating—at a level of approximately $500 million a year—our primary objectives are to upgrade our own technical competence by in-house training; to reduce the overhead in dramatic ways; to try through all avenues to insure that the customer gets more for his dollar; to direct our technical efforts in ways that are of long-term benefit to the company; to concentrate on the excellence of our product, confident that if this is done, the advantages to stockholders will be a natural result." ⁂

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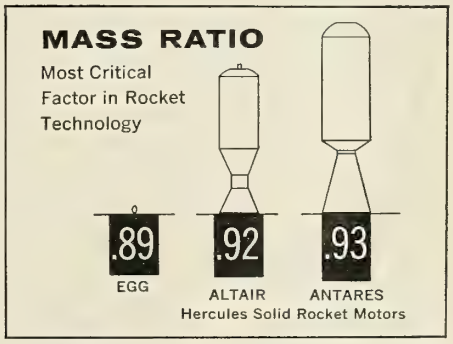

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EE's, ChE's, ME's (BS, MS). Design & Development instrumentation to obtain test firing data, also D&D process instrumentation.

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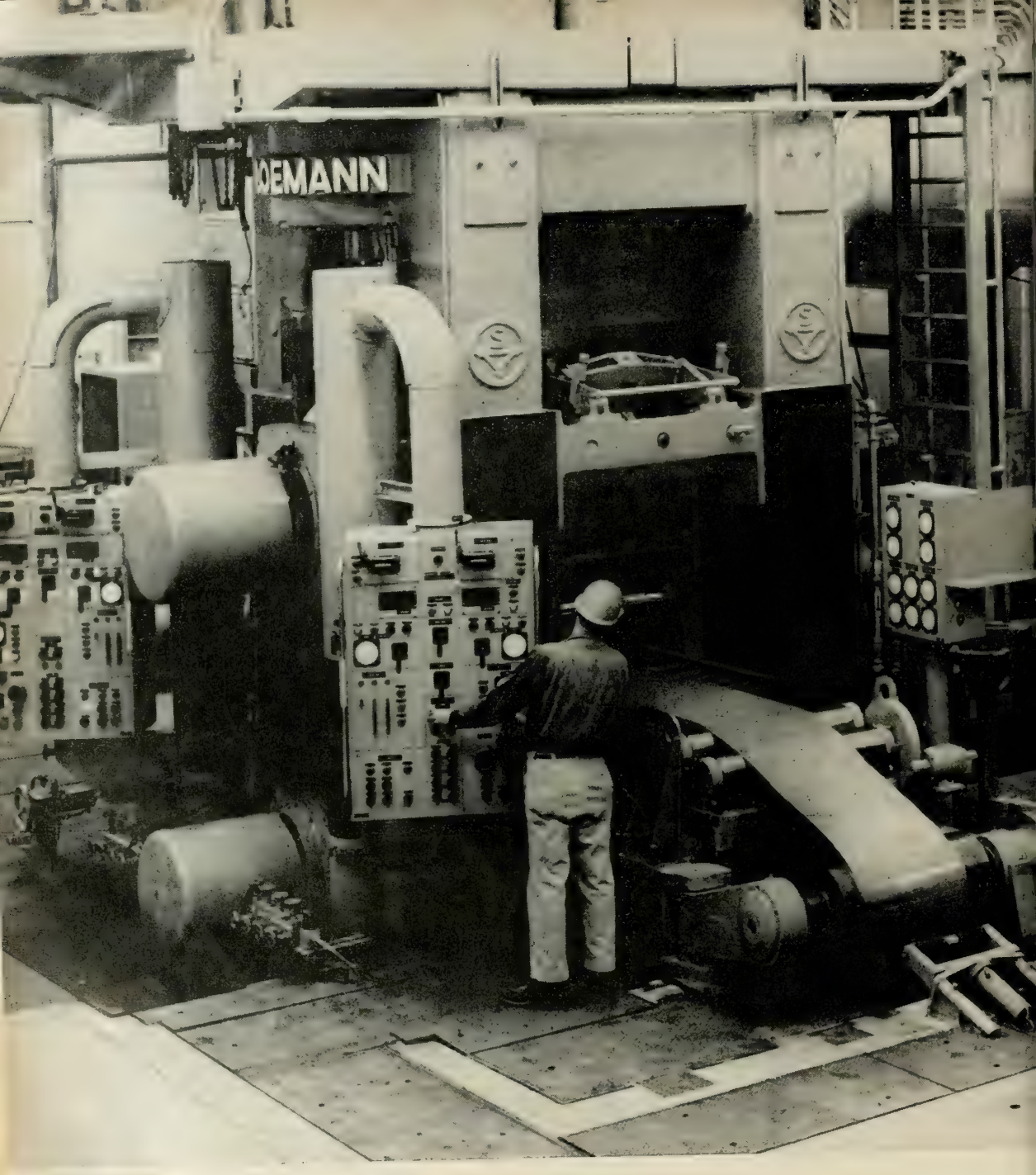

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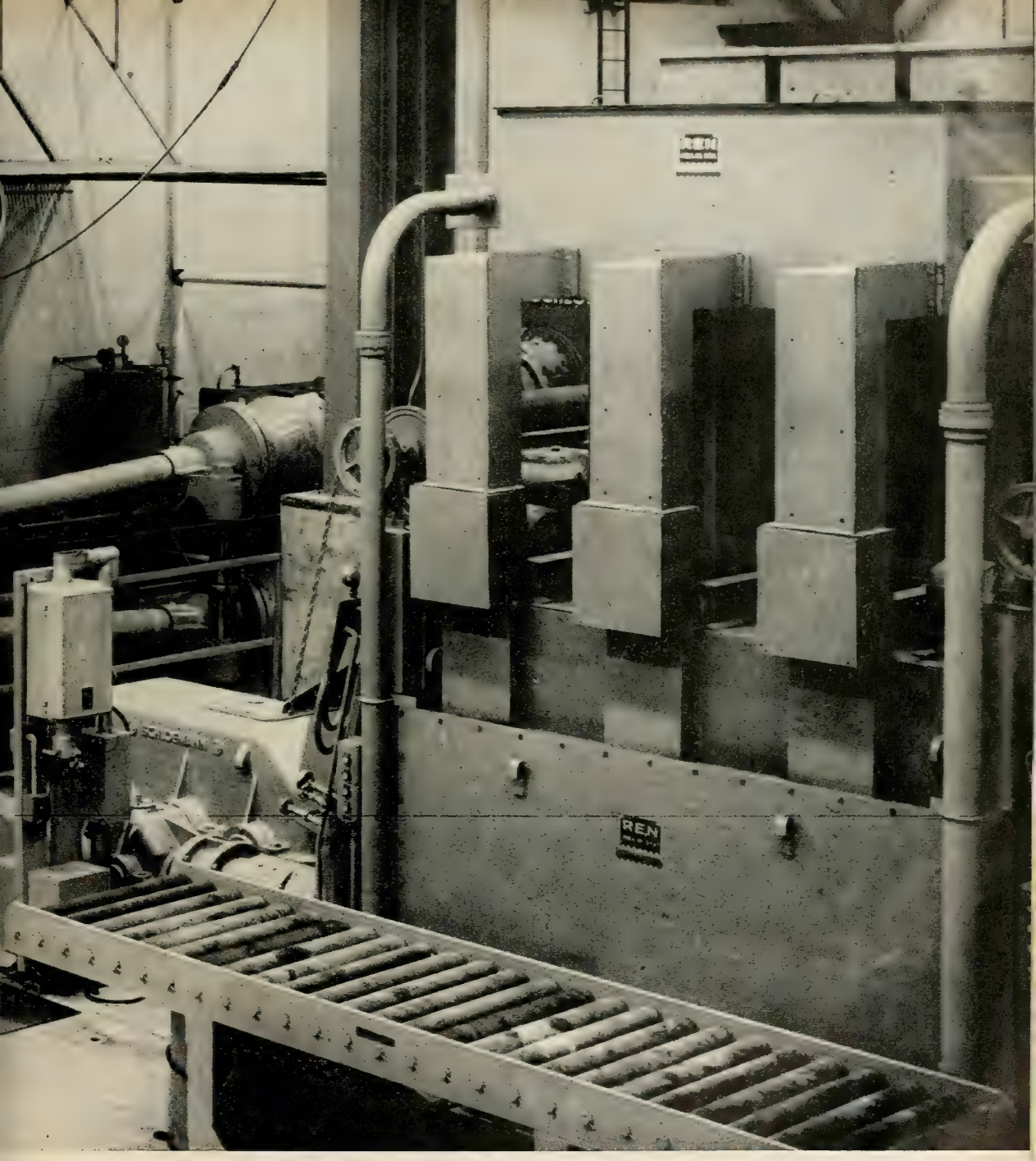

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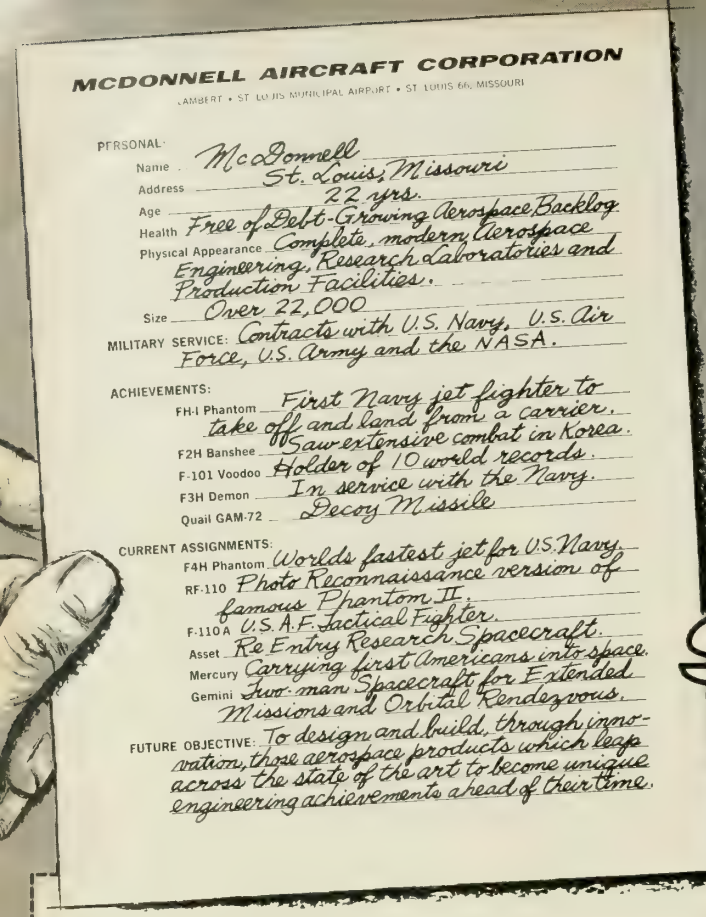
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Insulation Readied for Big Boosters

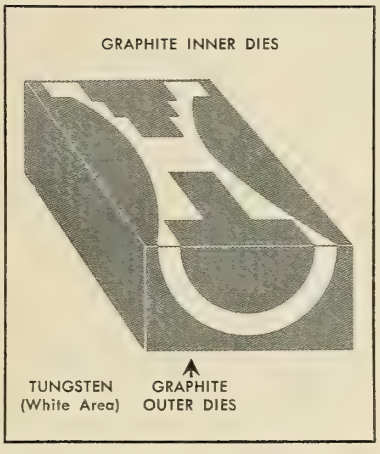
by A. P. Peters
Project Engineer
United Technology Corp.

INSULATION TECHNIQUES using elastomeric rubber for the case and a combination of graphite materials and leached glass fibers in the nozzle are being scaled up from test-motor size to the large-solid-booster regime at United Technology Corp.

Performance of both insulation types was satisfactory in the three 15,000-lb.-thrust test motors. Thermal and erosive characteristics of the rubber were better than expected. The high temperatures and flame of the burning propellant reduced the plastic state of the rubber to a hard char. This char, primarily a surface condition, did not impede the insulation properties of the rubber—as long as the bond to the case remained.

Insulations for both motor case and nozzle were fabricated for UTC by the Dumont Mfg. Corp., subsidiary of H. I. Thompson Fiber Glass Co.

• **Tape-wound best**—In the nozzles, the erosion characteristics of the tape-wound oriented graphite cloth were superior to those of molded-mass graphite. In any transverse area, erosion was quite smooth and consistent. Longitudinally, the graphite cloth eroded somewhat more in those areas closer to the nozzle, but there was no evidence of the chunking typical of compositely molded graphite and leached glass.



NOZZLE CUTAWAY illustrates relative positions of mass graphite, oriented tape and silica cloth. MX2630A is Fiberite's oriented graphite cloth, and #2625 is the silica cloth compound.

There was also no noticeable erosion differential at the boundary "step" of the graphite cloth and mass graphite. Erosion was more pronounced at the beginning of the leached glass. This is to be expected since this material erodes faster than graphite.

Since only three nozzles were required for the UTC feasibility program, the composite insulation was molded by the Dumont-developed hydroclave process. This method, which utilizes hydraulic fluid as the pressure medium, provides three distinct advantages in molding complex nozzle configurations:

—Tooling costs are reduced. The hourglass shape of the nozzle insulation would have required expensive matched metal dies.

—The high molding pressures obtainable (1000-2000 psi) are equivalent to compression molding and much greater than autoclaving.

—The undesirable sectioning of the exit cone and splicing of insulation was eliminated.

The throat area of the nozzle consisted of a mass type of graphite backed up with a phenolic-impregnated asbestos tape. This combination was cured at 300 psi, and then machined to the steel contour.

The exit cone's ablative liner was made up of tapes of graphite cloth and Refrasil (R) fiber, both wrapped parallel to the center line of the motor to give a 15° edge-grain orientation to the inside diameter. This type of configuration was based on tests which proved

Molding Compounds Functionally Engineered

THE INSULATION MATERIALS used by Dumont in fabricating the test nozzles for UTC were developed by the Fiberite Corp., Winona, Minn. The firm does no production molding itself but is a supplier of molding compounds.

Fiberite first integrated National Carbon's graphite cloth into high-temperature molding applications by introducing refractory oxides into the resin. Although not affecting the room-temperature properties, the mineral additives apparently reflect the infrared concentration contributed by aluminum-bearing propellants.

Fiberite developed a graphite-composite insulation molding compound by chopping the graphite cloth into 0.5-in. squares and molding under pressures from 1000 to 3000 psi. These high pressures and the backing-up with insulating structural materials of silica cloth led to production of free-standing molded plastic cones.

Key to the use of such successful composite materials is the selection of completely compatible resins for the graphite cloth and silica cloth portions of the structure.

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THE QUIET MEN

Today, we're united in one of the hardest fought crusades the world has ever seen —the all-out assault on every frontier of scientific knowledge. Yet the beginnings of these ventures are not marked with fanfare. The battles and victories are often fought and won in complete loneliness by a single man... or by groups of men sharing their knowledge. From their quiet yet unrelenting research efforts come the theories that one day make the headlines.

Never before have such men been so needed; never before has their stimulus been so great; never before have their findings been so significant.

Our nation's investment in military and scientific research alone is already yielding dividends in terms of America's economic growth. Many of the new jobs, products, services, and even industries that today loom large on the American scene are the fruits of ideas put to work in the last decade.

Since its earliest days, America's aviation industry recognized the significance and need for extensive research activities. Today the aviation industry is better known as

the aerospace industry. No longer is it known only for its leadership in aircraft; it is now recognized as a dynamic force in many other fields: chemistry... computers... nuclear energy... communications... life sciences... electronics... propulsion... naval technology... navigation.

Through this research and diversification, the aerospace industry is contributing to the advance of the Free World's scientific progress. And here—as in all American industry—the quietest roles are often played by the men of science whose accomplishments are bettering the lives of all.

These are the men of research... the men whose vocabulary does not include the word "impossible."

These are the quiet men.

North American Aviation is at work in the fields of the future through these six divisions: Atomics International, Autonetics, Columbus, Los Angeles, Rocketdyne, Space & Information Systems.

FEASIBILITY MOTORS consisted of an aft closure, a center cylindrical section and forward closure. Mass graphite insulation is visible in nozzle.

AFT CLOSURE WAS INSPECTED in this special rig. The overlapping layers of bonded rubber insulation are clearly visible here.

that a hydroclave-molded, edge-grain oriented graphite or leached-glass tape will withstand erosion better than chopped fiber compounds molded at high pressures in metal dies.

The graphite was tape-wrapped first, beginning at the nozzle end of the cone, and extending down about 5 in. from the mass graphite toward the exit plane of the nozzle. It was then debulked by a preforming process which uses low pressure and temperatures up to 200°F to compress the material and partially devolatilize the resin. Debulking makes the tape machinable and pre-positions the material for the final curing process so that print dimensions of the inner faces of the composite can be met.

The entire length of the cone, starting behind and running the full extent of the graphite cloth, was overwrapped with Refrasil tape, preimpregnated with phenolic resin. Following tape wrapping the unit was bagged and hydroclave-molded at 1000 psi.

The entrance cap in the case just before the nozzle throat was a 60° oriented leached-glass/phenolic wrapping.

• **Chamber insulation**—Three steel segments made up the case of each 7-ft.-long test motor. The center cylindrical section was attached to the dish-shaped aft and forward closures with a circumferential clevis joint and shear pin arrangement. Interior surfaces of the three segments and all joints were lined completely with the insulating rubber. This is a silica-loaded, flexible, elastomeric compound which has excellent thermal qualities, can absorb a high degree of mechanical shock and adds a minimum of weight to the case.

The sheet rubber was built up in a number of layers. Thick sections, up to 20 piles in some areas, were applied where propellant burn-through might have been expected first. Apart from the need for precisely determined thicknesses of insulation in each segment to provide adequate protection, there had to be uniform transitions from thin to thick sections. For the joints of the case, the rubber was formed to ensure perfect mating of adjoining insulation, and to provide a tight seal when case sections were assembled.

The interior metal surfaces of the three segments were cleaned chemically. The rubber sheets were then bonded in place with a rubber-based adhesive. With each individual layer, care was taken to avoid air spaces or entrapment of volatile solvents—either might have led to bond failure and resultant overheating of the motor case. The rubber was cured at an elevated temperature and medium pressure in an autoclave in which inert gases are used as the pressure medium. ⌘

Microminiature Coaxial Connectors

Microdot's microminiature connectors—including the world's smallest 50-ohm coax connectors—are available in over one million combinations. Plugs are available in straight or angle screw types and slide-on versions. Receptacles include printed circuit and bulkhead feed-thru types. Only highest quality materials are used. Conductors are of silver-plated copperweld or cadmium bronze, center contacts are of gold-plated coin silver. Housings are silver-plated brass to assure minimum electrolysis with aluminum panels. "Teflon," "Kel-F," polyethylene, and neoprene are used as dielectrics, jackets, bend relief caps, and pin protectors.

Microdot Inc., 220 Pasadena Avenue, South Pasadena, California

Circle No. 7 on Subscriber Service Card

Crimp-type Connectors

These solderless, coaxial connectors are available in a variety of mounting configurations, including snap-locking versions. Male and female connectors may be mounted interchangeably. Mated length is $1\frac{13}{16}$". Working voltages: 1,000 V. maximum, at sea level; 500 V. maximum, at 60,000 feet. VSWR; less than 1.2 up to 2,000 mc. Life; 5,000 matings, minimum, without electrical deterioration. Tensile strengths of the crimps exceed the breaking strength of the cable. Hard gold plated Beryllium copper and TFE plastic are extensively used to assure optimum reliability.

Microdot, Inc., 220 Pasadena Avenue, South Pasadena, California

Circle No. 8 on Subscriber Service Card

61 POWER CONTACTS IN A 1⅛" SHELL

NEW MICRODOT MICROMINIATURE MULTI-PIN CONNECTORS

These rugged, reliable "43" Series Microdot Microminiature Multi-pins are only ¼ the size, ⅓ the weight of previously available miniature multi-contact connectors. Yet performance equals or exceeds MIL-C-26482 and applicable paragraphs of MIL-C-26500. Ready now for advanced applications, these connectors pack up to 61 power contacts—or 19 coaxial contacts—or a combination of both—into a shell the diameter of a quarter.

Improved three-keyway design of the "43" Series prevents pin engagement with insert face, permits 14 alternate positions for each insert layout by "clocking" shell keyways rather than inserts. Inserts come in a variety of straight power, straight coaxial, and combination power-coaxial layouts. The Multi-pin design accommodates a mix of male and female contacts in either plug or receptacle without changing inserts, allowing hot or cold leads to either side. Closed-entry, crimp or solder contacts are gold-plated pure coin silver to resist wear, maximize ampere ratings and conductivity, minimize temperature rise and resistance. Positive, push-pull, quick-disconnect coupling eliminates need for safety wire. Operating force is always in direction of plug travel.

With all parts interchangeable, the "43" Series Microdot Microminiature Multi-pins are available now in disassembled kit form (for bench assembly or on-the-spot field circuit design), or factory assembled (as basic connectors) or as complete assemblies (with Microdot cable). Write today for illustrated, detailed Bulletin MP-0.

Microdot Multi-pin Connector Kit

SIZE DESIGNATION	PLUG O.D.	NO. OF COAXIAL CONTACTS	NO. OF POWER CONTACTS
A	¾"	up to 7	up to 19
B	1⅛"	up to 12	up to 37

MICRODOT INC.

220 Pasadena Avenue, South Pasadena, Calif.

MUrray 2-3351 SYcamore 9-9171

AC, The Electronics Division of General Motors, is now seeking *creative* engineers, physicists and mathematicians to fill important and challenging positions in the Advanced Navigation Field. The positions:

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Systems Engineers and Mathematicians
Electronic Circuit Engineers
Mechanical Design Engineers
Instrument Engineers
Electromagnetic Engineers
Radar Systems Engineers

Los Angeles Research and Development Laboratory

(Advanced Inertial Guidance Systems and Airborne Digital Computers)

Digital Computer Development Engineers
Research and Development Engineers
Transistor Circuit Design Engineers
Systems Engineers

Milwaukee

Military Defense Systems, Program and Project Engineers
Radar Design and Development Engineers
Radar Systems Engineers
Radar Test Engineers
Reliability Program Engineers
Field Service Engineers
Electromagnetic Engineers
Supplier Contact Engineers
Quality Control Engineers/Analysts
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Scientific Programmers

If you are experienced and interested in any one of these positions, please send your resumé to Mr. G. C. Raasch, Director of Scientific and Professional Employment, Dept. 5753, 7929 S. Howell, Milwaukee 1, Wisconsin. We are an Equal Opportunity Employer.

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To fill 'range gap'. . .

Pentagon Presses MRBM Development

by James Trainor

INITIAL FUNDING of the Air Force's Mid-Range Ballistic Missile in Fiscal 1963 will be $100 million—indicating the Defense Department has placed a high priority on development of the mobile system.

One of the few new missile systems included in this year's DOD budget, the MRBM will be a two-stage, solid-propellant missile—lighter and more accurate than any system now under development. Its guidance system, already under development, will be a stellar-inertial platform. The missile will carry a nuclear warhead.

The entire system, including missile, checkout, launch and command and control equipment, will be housed in one vehicle. The truck, with a 3-5-man crew, will be hardened to some degree to withstand the effects of a nuclear blast.

• **AF management setup**—Development of the MRBM will be the responsibility of the Air Force System Command's Ballistic Systems Division, assisted by Aerospace Corp.

With a goal of late 1965 or early 1966 for an operational system, AF officials are moving quickly to set up the contractor structure for the development program.

Requests for Proposals (RFP) were to go to industry this month. They will cover six development areas: Propulsion, Command and Control, Re-entry Vehicle, Transport-Launcher, Guidance and Control and Systems Integration, Assembly and Checkout.

Since the entire system is felt to be well within present state of the art and industry has been studying the MRBM problem for some time, the Air Force will allow only four to six weeks for the submission of proposals. The entire contractor team, AF officials say, will be assembled before June 30, the end of this fiscal year.

Competitive contracts for the development of the stellar-inertial guidance system were awarded last year to GM's AC Spark Plug Div. and General Precision's Kearfott Div. The two systems will be evaluated and the development contract awarded to one of the two companies this spring.

The company awarded the contract for Systems Integration, Assembly and Checkout will supervise other contractors to ensure that all subsystems are compatible with the overall system.

• **Versatile system** — A mobile, quick-reacting system, the MRBM is designed to be self-sufficient, with all equipment necessary to fire the missile contained in one van. However, due to its range capabilities (300-1500 miles), the MRBM will not be deployed in the United States, but will travel the roads of Western Europe and the Far East.

The Navy will work with the Air Force during development of the system to ensure that it also can be deployed aboard surface ships.

In addition to the truck and ship-mounted versions, the MRBM is expected to be adaptable to hardened sites. Specifically, since the MRBM is to replace the *Mace*, it could presumably be installed in the hardened facilities now under construction in Europe for the three air-breathing missile squadrons deployed there.

Air Force officials also concede that the new system would be capable of replacing the *Jupiter, Thor* and *Matador* systems now deployed with Italian, British and West German troops.

• **Command and control**—Writing in the Air University Quarterly Review, Maj. Gen. Stanley J. Donovan, deputy for operations at Headquarters, Tactical Air Command, pointed out that "one of the major complications (in the MRBM deployment) might be in developing a positive command and control system to permit random dispersal and still guarantee quick reaction."

AF officials point out, however, that the command and control system will be compatible with existing command networks in any given theater while, at the same time, able to operate as a separate and self-sufficient system.

The system also is being designed to include postive safety features to preclude launch of the missile by the crew without authorization from higher headquarters.

A self-contained system such as the Mobile Mid-Range Ballistic Missile (MMRBM)—Air Force terminology for the truck-mounted version—lends itself to camouflage and deception techniques.

• **Range gap filled** — Secretary of Defense Robert S. McNamara reported in testimony before the Senate Armed Services and Appropriations committees that the MRBM "would fill the 'range gap' in our present missile programs between the *Pershing* with a range of over 300 miles and our ICBM's with ranges in excess of 5000 miles."

Soviet developments in this range spectrum have long been a matter of concern to defense planners.

The requirement for an MRBM, according to an Air Force official, has existed since 1957. However, until about a year ago, nothing was done to meet this need other than to revise the requirement to conform with the existing state of the art.

• **Why the Air Force?**—With the new Administration came renewed interest in the MRBM and an effort by each of the services to adapt their pet projects to meet the MRBM requirement. The Army championed an Advanced *Pershing* while the Navy talked of a *"Polaris* on wheels".

However, each of these approaches involved a new propulsion, guidance and checkout scheme as well as a new re-entry body—in other words, a new missile system, whatever its name.

The Defense Department therefore decided to initiate a development program for a new missile system which would be within the state of the art in order to minimize both development time and money.

Since the Air Force is charged with the major portion of the tactical mission of battlefield interdiction, and dominates the interface between General Purpose and Strategic Retaliatory forces, it was designated to develop the MRBM.

• **NATO weapon?**—Although Secretary McNamara has said that the plans for employment of this missile are "still highly tentative," the possibility of the system replacing *Jupiter, Thor* and *Matador* now in the hands of foreign troops raises the question of whether this system is, in fact, a NATO weapons system.

Last May in Ottawa, President Kennedy said that he was willing to consider the idea of a multilaterally controlled missile force. At that time, the President's only firm offer was to put five or more *Polaris* submarines in "the NATO command area."

Air Force officials, however, are extremely reluctant to discuss the MRBM as a NATO weapon. ⌗

The Industry Week

Highlights of Missile Labor Meeting

The missile industry has for the first time outstripped its parent aircraft industry in employment, Labor Secretary Arthur Goldberg said last week. August, 1961, figures: 564,000 missile against 557,300 aircraft workers. Speaking before a joint UAW-IAM meeting aimed at presenting a unified labor front at upcoming contract negotiations in the aircraft, missile and electronics industries, Goldberg said labor and management had a joint obligation to reach strike-free contract agreements "consistent with the national interest." The union leaders maintain that steady employment is the top problem in the missile industry. They are preparing to ask for increased lay-off benefits from industry to compensate for shifts in production emphasis from aircraft to missiles. Also considered were plans calling for a government financial role in guaranteeing pay benefits for laid-off workers.

News of Mergers and Expansions

Control Data Corp. organized a System Sciences Division in Los Angeles to expand the company's defense and commercial data-processing and communications operations. The division will engage in study, research and preliminary design of information handling systems. . . . *ITT Kellogg's Communications Systems Department set up an Electronic Development Lab to design, develop and evaluate systems and subsystems in communications, command and control data-handling and switching.* . . . Allied Research Associates, Inc., a Boston R&D firm, will build a $750,000 building at Concord, Mass. . . . *PneumoDynamics Corp. stockholders have approved acquistion by the company of its parent company, Cleveland Pneumatic Industries, Inc.* . . . Kaynar Mfg. Co., Inc., began construction of a 126,000-sq.-ft. plant in Fullerton, Calif. . . . *Airborne Instruments Laboratory, division of Cutler-Hammer, plans to add 145,000 sq. ft. to its present facilities at Deer Park, N. Y.* . . . Geonautics, Inc., has formed a field engineering group in Washington, D.C., to conduct geodetic, astronomic and alinement surveys for large-dish antenna installation and calibration, missile-launch sites and inertial guidance test facilities. . . . *Fifth Dimension Inc. plans a new plant in Princeton, N.J. The company manufactures data-scanning components for aerospace, business and industrial applications.* . . . Packard Bell Computer Corp. has added more than 50,000 sq. ft. to its Los Angeles facilities. . . . *Special Devices, Inc., acquired Mimx Corp., Glendale, Calif.* . . . Insul-8-Corp., San Carlos, Calif., has acquired Sterling Manufacturing Co., Belmont, Calif. . . . *Perkin-Elmer Corp. organized an Optical Maser Department responsible for marketing crystals and lasers as well as conducting research in advanced optical production and testing techniques.*

International News Briefs

Avco Corp. and Ultra Electronics, Ltd., London, signed an agreement covering joint studies and possible joint ventures in communications and electronics. If they find it is feasible, the two may set up joint-venture companies. . . . *General Instrument Corp. and Pirelli S.p.A, Milan, Italy, concluded an agreement to form a European company serving the Common Market and other outlets. Pirelli Applicazioni Elettronichi, S.p.A, with headquarters in Milan and plant in Naples, will manufacture and sell GI's electronics product line. The parent companies will exchange technical information and personnel.* . . . Hughes Aircraft Co.'s *HM-55-S* air-to-air radar-guided missile has been selected by the Swiss government for integration with the Swiss Mirage III-S jet fighter-interceptor.

Production Line Notes

Ryan Aeronautical Co. will continue production of *Firebees* at least through 1963. A $7.4-million contract was awarded last week for over 200 *Q-2C*-model free-flying drones.

Corporate Financial Reports

Lockheed's Board Chairman, Courtlandt Gross, predicted company earnings for 1962 should rise 35% over 1961, to $35 million. "In the last few years," said Gross, "we have undergone a change from a purely aircraft industry to an aerospace industry. As this has happened we have been achieving a degree of stability that, as an aircraft industry, we had never known." . . . *Aerojet-General sales increased 13% in 1961 over the previous year; profits were up 17% to $11.8 million.* . . . Vitro Corp. of America income was up 21% in 1961 over 1960, despite lower sales volume. Reason: discounting of unprofitable operations. . . . *Litton Industries had earnings of $7.44 million for the first six months of the 1961-1962 fiscal year on sales of $168 million. Comparable figures for last year were $4.45 and $108 million.* . . . Westinghouse Electric Corp. had fourth-quarter 1961 sales of $526.3 million and earnings of $20.4 million. . . . *Zero Manufacturing Co. had record sales and profits for nine months ending Dec. 31. Sales were up 56%, earnings 177%.*

Change in the Front Office

Dr. William M. Duke was elected president of ITT Federal Laboratories. He joins ITT from Space Technology Labs, Inc., where he was senior vice president.

New Names in the Industry

Astronautics Foundation, Inc., has been formed in Washington, D.C., to "support all aspects of the natural and social sciences relating to astronautics and space flight." The foundation will administer funds designated for advancement of peaceful applications of astronautics and space flight. Chairman of the 14-man board of trustees is Dr. Theodore von Karman, and the first president is James E. Knott. Andrew G. Haley is Executive Vice President and Legal Counsel.

—contracts—

AIR FORCE

$10,000,000—**Boeing Co.**, Seattle, for production of aerospace ground equipment for the *Minuteman* missile.

$8,000,000—**General Dynamics Corp.**, San Diego, for continued work on the *Atlas* ICBM.

$7,373,496—**Ryan Aeronautical Co.**, San Diego, for production of *Q-2C* aerial target drones and related equipment.

$5,000,000—**General Dynamics Corporation**, San Diego, for the *Atlas E* updating program.

$5,000,000—**Thiokol Chemical Corp.**, Bristol, Pa., for research and development of an improved stage I solid-propellant rocket motor for the *Minuteman* missile. Work will be done in Brigham City, Utah.

$5,000,000 — **Aerospace Corp.**, El Segundo, Calif., for provision of systems engineering, technical direction, management services and administrative support for ballistic missile space programs.

$3,854,153—**General Dynamics Corp.**, San Diego, for installation and checkout of an operational test facility at Vandenberg AFB, Calif.

$3,723,410 — **Douglas Aircraft Corp.**, Santa Monica, Calif., for launch services at Vanderberg AFB and for development of an air-to-air rocket fuze (2 contracts).

$3,309,250—**Martin Marietta Corp., Aerospace Division**, Denver, for study of design criteria for a *Titan III* standardized space launch vehicle.

$3,000,000—**Lockheed Aircraft Corp.**, Sunnyvale, Calif., for provision of *Agena* equipment and launch support

$2,000,000—**Aerojet-General Corp.**, Sacramento, Calif., for research and development for *Titan II* propulsion systems.

$1,804,000—**General Electric Co.**, Syracuse, N.Y., for a prototype of an automatic nuclear detonation detection and reporting system (NUDETS).

$1,656,876—**Douglas Aircraft Co.**, Santa Monica, Calif., for launch support services at Vandenberg AFB, Calif.

$1,500,000—**Aerojet-General Corp.**, San Ramon, Calif., for research and development for a pilot plant for production of hydrazine rocket fuel.

$1,018,000—**McDonnell Aircraft Corp.**, St. Louis, for research and development on re-entry vehicles.

$630,821—**ACF Industries, Inc.**, Hyattsville, Md., for work on a classified project (supplemental contract).

$400,000—**Radio Corporation of America, Defense Electronic Products**, Burlington, Mass, for conceptual study of an operational flight control scheme for the *Saturn*-class space vehicle.

$235,007 — **General Electric Co.**, Syracuse, N.Y., for production of test instrumentation and components for an air weapons control system for defense against air-breathing weapon systems.

$82,250—**Ford Motor Co.**, Newport Beach, Calif., for fabrication, integration, flight check, and technical assistance on launch of *Blue Scout* vehicles. Work will be performed at Newport Beach and Patrick AFB, Fla.

ARMY

$16,343,522—**Sperry Rand Corp.**, Salt Lake City, Utah, for *Sergeant* guided missiles engineering services, production and ground equipment (2 contracts).

$10,700,000 — **General Dynamics/Pomona**, Calif., for continued research and development work on the *Mauler* weapon system.

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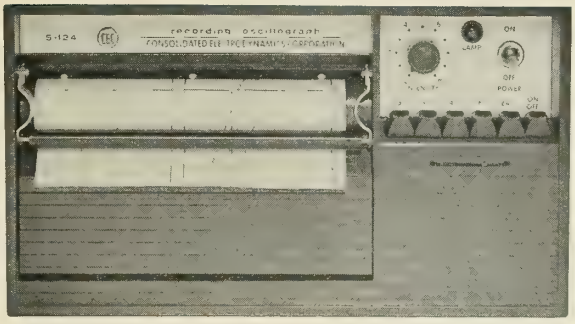

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You're looking at CEC's model 5-124 Recording Oscillograph. Even without accessories, this small, 18 channel instrument has big capabilities. With accessories, it fulfills the need for any special application requirements you might have. For example:

It can automatically expose a grid-line system on the record in either 0.1-inch increments with each tenth line accentuated or millimeter increments with each fifth line accentuated.

It can identify all traces by sequential interruption at a 12″ repetition cycle.

It can place a number along the edge of the record opposite each trace interruption, corresponding to the galvanometer channel position.

It can have a full record width electronic flash timing system that provides switch selected timing intervals of 0.01, 0.1, or 1.0 second. Timing system can be synchronized from an external source at frequencies up to 100 pps.

It can stabilize the galvanometer block at 100°F.

It can provide record speeds on special order of 0.125, 0.5, 2.0, 8.0, 32.0 inches/sec. or 0.25, 1.0, 4.0, 16.0, 64.0 inches/min.

It can have a motorized record take-up unit that attaches to the front of recorder and automatically spools oscillogram.

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Data Recorders Division

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$3,903,266—**Thiokol Chemical Corp., Longhorn Division,** Marshall, Tex., for production of rocket and missile motors.

$3,900,000—**Raytheon Co.,** Bedford, Mass., for detailed field tests of the experimental ARPAT interceptor antimissile defense concept.

$1,865,179—**Aerojet General Corp.,** Sacramento, Calif., for metal parts for *Hawk* missile rocket motors.

$491,900—**J. Hilbert Sapp, Inc.,** Orlando, Fla., for construction of a spacecraft assembly building at Cape Canaveral for NASA.

$98,375—**Rocket Power Inc., Div. of Gabriel Co.,** Mesa, Ariz., for rocket engines.

INDUSTRY

$5,000,000—**Lockheed Propulsion Co.,** Redlands, Calif., from **Space and Information Systems Division of North American Aviation, Inc.,** for design and configuration of a solid propellant launch escape motor for the *Apollo* spacecraft.

$1,000,000—**Dynalectron Corp.,** Washington, D.C., from **Boeing Company's Military Aircraft Systems Div.,** Wichita, Kan., for manufacture of infrared countermeasures system.

$600,000—**Eitel-McCullough, Inc.,** San Carlos, Calif., from **Radio Engineering Laboratories,** Long Island City, N.Y., for high-power microwave klystron tubes and associated circuitry for use in troposcatter radio transmitters.

$300,000—**Packard Bell Electronics Corp.,** from **Ford Instrument Division of Sperry Rand Corp.,** for two shipboard data systems for tracking at the Atlantic Missile Range

NAVY

$48,189,123—**Raytheon Co.,** Lexington, Mass., for *Sparrow III* guided missiles, work to be done at Waltham, Lowell and Bedford, Mass., Oxnard, Calif., and Bristol, Tenn.

$8,176,300—**General Electric Co.,** Washington, D.C., for main propulsion machinery, associated parts and services for four *Polaris* submarines. Work will be performed at Lynn and Fitchburg, Mass.

$6,115,000—**Martin Marietta Corp.,** Orlando, Fla., for production of *Bullpup* missiles.

$4,144,450—**Westinghouse Electric Corp.,** Washington, D.C., for two *Polaris* main propulsion machines and associated onboard repair parts, special tools, tests, technical data and stock components. Work will be performed at Essington, Pa.

$2,797,294—**Western Electric Co., Inc., Defense Activities Division,** New York City, for fire control equipment for *Tartar* missiles. Work will be accomplished in Winston-Salem, N.C.

$1,770,000—**General Dynamics Corp.,** Pomona, Calif., for further development work on the *Terrier/Tartar* missile systems.

$1,489,879—**General Electric Co.,** Washington, D.C., for research and development of BuWeps documentation for the Mark 2 guidance system. Work to be performed at Pittsfield, Mass.

$600,227 — **Minneapolis-Honeywell Regulator Co.,** Hopkins, Minn., for *ASROC* missile components.

$299,950—**Sperry Gyroscope Co., Air Armament Div.,** Great Neck, N.Y., for manufacture of inertial components for use in *Polaris* guidance systems.

$160,871—**Hughes Aircraft Co.,** Culver City, Calif., for facilities in support of the contractor's performance in the Fleet Ballistic Missile program.

$107,300—**Aerojet-General Corp.,** Sacramento, Calif., for facilities in support of the contractor's performance in the Fleet Ballistic Missile program.

$70,000—**Aircraft Armaments, Inc.,** Cockeysville, Md., for field engineering services for *Terrier/Tartar/Talos* telemetry equipment.

Togetherness, with Greater Isolation... by new NEMS-CLARKE® Multicoupler

Another new addition to the Nems-Clarke line of telemetry equipment is the Solid State Multicoupler, SSM-101. It accepts the output of an antenna-mounted preamplifier and provides eight outputs with a minimum isolation between any two outputs of 50 db. The gain is held to approximately unity and is flat within 3 db across the band.

The SSM-101 is designed for use in the 225-260 megacycle telemetry band but can be supplied to cover other bands between 55 and 300 megacycles. Input and output connections are made at rear of the unit through type C connectors. Its integral power supply will also energize the Nems-Clarke Solid State Preamplifier, SSP-101.

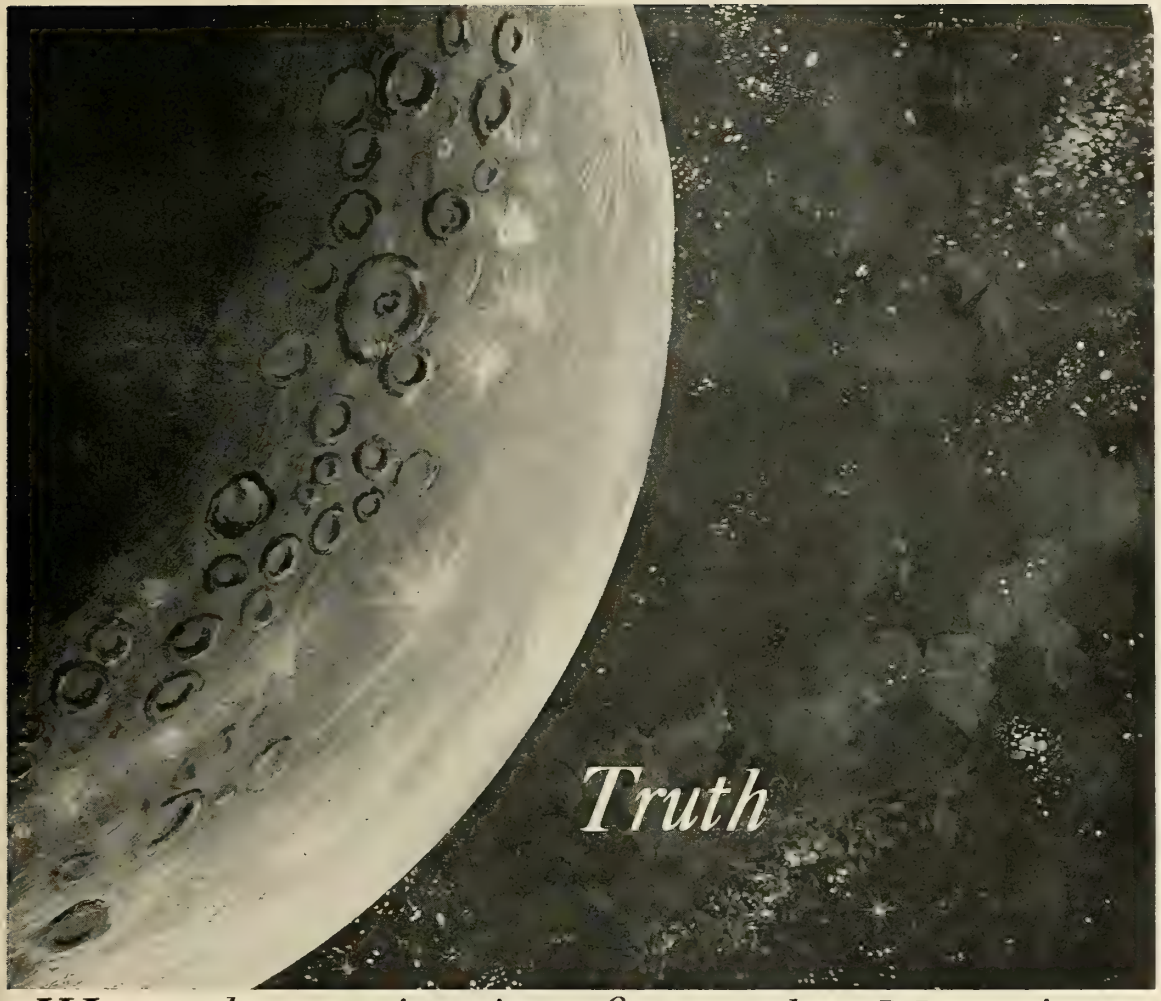
Write for Data Sheet 899.
Vitro Electronics, 919 Jesup-Blair Dr.
Silver Spring, Maryland
A Division of Vitro Corp. of America

VISIT VITRO AT I.R.E. SHOW
Booth 3821-3823.

Vitro ELECTRONICS

Specifications

1. Pass Band	225-260 megacycles
2. Uniformity response	within 3 db
3. Gain	approximately unity
4. Isolation	between outputs 50 db minimum
5. Receiver outputs	8
6. Impedance	Designed to operate in 50 ohm system
7. Power source 115 v, 60 cps.	approximately 6 watts
8. Connectors	type C



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If you are then interested in knowing specific details, address your resume in confidence to: Professional Employment Manager, Guided Missiles Range Division, PAN AMERICAN WORLD AIRWAYS, INC., Dept. V-47, P. O. Box 4336, MU 113, Patrick Air Force Base, Florida. Inquiries will receive prompt replies and all qualified applicants will be considered for employment without regard to race, creed, color or national origin.

PAN AM

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PATRICK AIR FORCE BASE, FLORIDA

Circle No. 9 on Subscriber Service Card

Hughes Aircraft Company has appointed six new vice presidents: **John W. Black,** vice president and manager of the aeronautical systems division, aerospace group; **Joseph Ferderber,** vice president and manager of El Segundo division, aerospace group; **Lester M. Field,** vice-president and assistant group executive, components group; **William L. Hoffman,** vice president of administration and materiel; **Charles B. Huestis,** vice president and treasurer, and **John L. Winkel,** regional vice president. Winkel will remain in Washington, D.C., while the others will be located in the Los Angeles area.

Thomas H. Morrin and **Hugh P. Moore:** Elected to the board of directors of Radiation at Stanford, Palo Alto, Calif.

John K. Records: Named manager of the *Apollo* study contract recently awarded by NASA to General Electric's Defense Systems Department, Syracuse, N.Y.

Herman A. Bruson: Promoted to vice president and senior scientist, and **S. Jackson Wommack** to vice president-research, of the Organics Division Olin Mathieson Chemical Corp., Olin Research Center, New Haven, Conn. Wommack will also be responsible for development at the Doe Run organic chemicals plant, Brandenburg, Ky.

R. W. Kaplan: New president of the Owatonna Tool Company, Owatonna, Minn., succeeding **A. R. Kaplan,** who has been made vice chairman of the board.

Arthur J. Cussen and **William E. Standring, Jr.:** Continuing to head divisions of Infrared Industries, Inc., have been appointed vice presidents.

James R. Harris: Has joined Celanese Chemical Company, a division of Celanese Corporation of America, as vice president-marketing.

Robert S. Alexander: Chairman of the board of directors of the Wells-Gardner Electronics Corp., Chicago, elected vice president of the newly-formed U.S. Instrumentation and Equipments Group of International Telephone and Telegraph Corp.

Reuben J. Bierke: Becomes vice president-manufacturing at the Columbus, Ohio, division of North American Aviation, Inc., succeeding Reginald G. Clarke, who has been transferred to the Autonetics Division, Downey, Calif., as vice president-central administration.

Brig. Gen. Charles H. Terhune, Jr.: Will replace **Maj. Gen. Kenneth P. Bergquist** as commander, Electronic Systems Division, Air Force Systems Command, L. G. Hanscom Field, Mass.

Robert H. Essig: Has been promoted to the post of contracts manager at Lear-Romec Division, Lear, Inc., Elyria, Ohio.

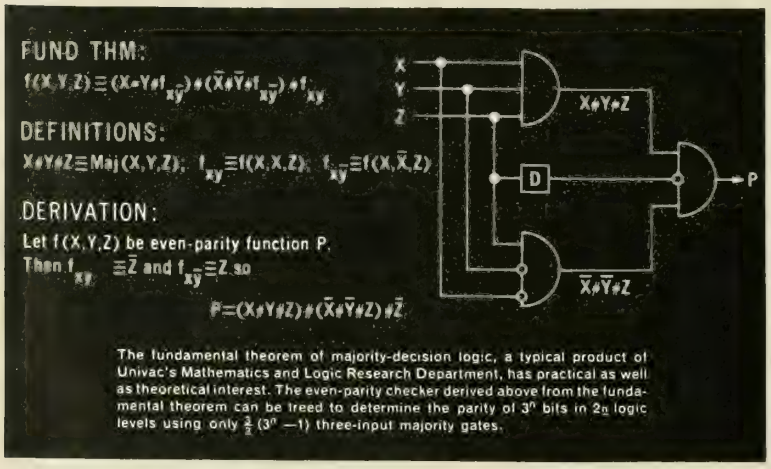
Jesse R. Lien, Richard M. Osgood, and **H. C. Tittle:** Promoted from general managers to vice presidents of Sylvania Electronic Systems, a division of Sylvania Electric Products Inc.; Lien as vice president and general manager of western operation in Mountain View, Calif.; Osgood as vice president and general manager of the eastern operation in Waltham, Mass.; and Tittle, vice president and general manager of the central operation in Buffalo, N.Y.

Kenneth V. Tindall: Has been brought into Gulton Industries, Inc.'s Washington, D.C., office, as systems marketing specialist.

Richard F. Uhlmann: Named to the board of directors of Chicago Aerial Industries, Inc., Barrington, Ill.

M. J. Connolly, Jr. and **Raymond P. Moore:** Appointed to the positions of vice president-manufacturing and vice president-sales and marketing, respectively, of General Devices, Inc., Princeton, N. J.

DERIVING majority logic NETWORKS



The fundamental theorem of majority-decision logic, a typical product of Univac's Mathematics and Logic Research Department, has practical as well as theoretical interest. The even-parity checker derived above from the fundamental theorem can be treed to determine the parity of 3^n bits in $2n$ logic levels using only $\frac{3}{2}(3^n - 1)$ three-input majority gates.

Qualified applicants will find at Remington Rand Univac a scientific climate tuned to the intellectual curiosity of the professional man. The opportunity and the incentive for advancement are waiting for you in highly significant positions at Univac. You are invited to investigate them immediately.

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Remington Rand Univac • Univac Park • St. Paul 16, Minn.

COCOA BEACH, FLORIDA

A new data processing center is being established in the Cocoa Beach, Florida, area to service the Atlantic Missile Range. Qualified applicants interested in a Florida location can be offered very challenging work on essential range problems. Openings include: • PROGRAMMERS • SYSTEMS ANALYSTS for correlation of radar tracking data and programming techniques for data handling and data reduction.

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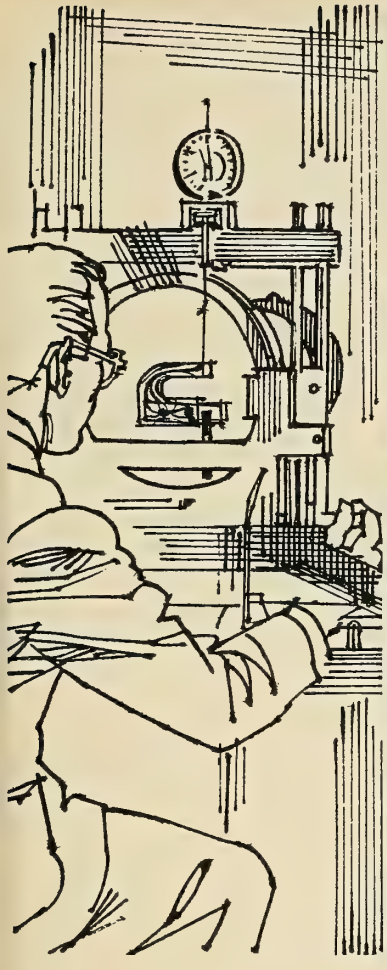

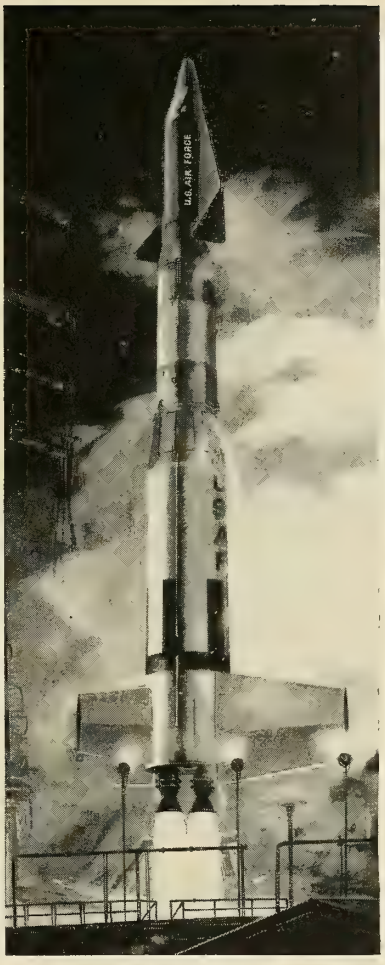

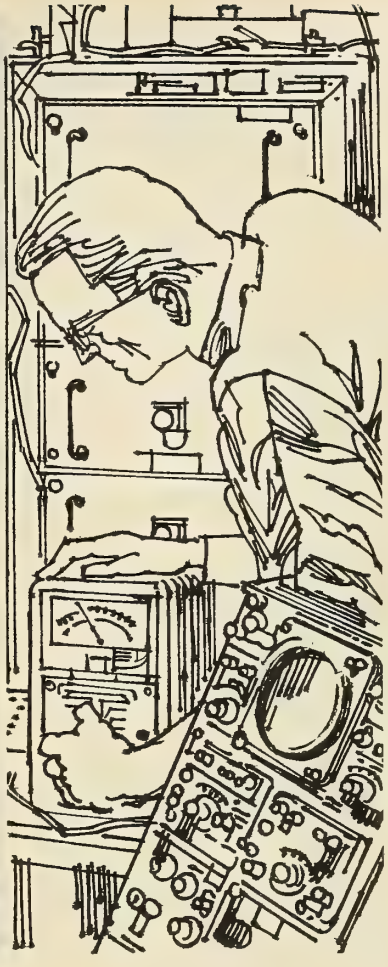

Advanced-program openings at Boeing for

STRUCTURAL AND ELECTRONIC/ELECTRICAL ENGINEERS

Boeing's Aero-Space Division, holder of major contracts on such advanced space programs as SATURN, DYNA-SOAR and MINUTEMAN, has a number of immediate, long-range openings offering professional challenge, and in many instances, unique ground-floor opportunities in newly-formed divisional organizations.

STRUCTURAL engineering openings require knowledge of the air loads, high heating rates, extreme differential temperatures, material oxidation and creep associated with advanced vehicles designed for flight regimes ranging from orbital to normal landing speeds.

ELECTRONIC/ELECTRICAL engineering assignments are available in many areas, including the design of electronic equipment, the development of improved design techniques, electronic parts, electronic packaging techniques and the design and development of improved electronic systems.

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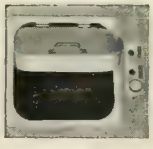

Circle No. 16 on Subscriber Service Card

New Product of the Week:

Diffusion Furnaces

A GROUP of 4-in-1 gaseous diffusion furnaces were recently developed by C. I. Hayes, Inc., for diffusing silicon wafers at 1300°C. Each of the furnaces consists of four diffusion units mounted on a control cubicle, and each unit incorporates tubes 2-in.-ID by 26-in.-long surrounded by zirconia mufflers. Temperature settings are established for each unit by separate instruments and controls to maintain a 16-in. flat zone with a temperature uniformity within ±1°C.

Circle No. 225 on Subscriber Service Card

Wire Solder Dispenser

A wide range of bayonet probes for electronic soldering has been announced by Commercial Products Div., International Electronic Research Corp. The extension probes swivel into any position desired, and provide backup pressure on solder at point of soldering as well as providing a means of holding the lead in position in difficult-to-reach places in a chassis.

The heat-sink probe has a longitudinal groove which serves to index the probe on the lead of transistor, diode or other heat-sensitive component, and has eliminated the need for heat-sink clamps in many applications. The stubby probe was developed specifically for the soldering of connectors.

Circle No. 226 on Subscriber Service Card

Silicon Mesa Transistors

VHF silicon mesa transistors in the medium power range are available from Clark Semiconductor Corp. The transistors, triple-diffused NPN mesa devices utilizing advanced production techniques, are designated type SN-101—rated at 200mc with a minimum output of 3 watts in amplifier circuits, and type SN-102—rated at 100mc with a minimum output of 5 watts in amplifier circuits. Although they are de-

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signed for use in amplifier service up to 250mc, oscillator operation is possible up to 400mc.

Circle No. 227 on Subscriber Service Card

Gyro Test Table

American Optical Co., Fecker Division, has developed a multimode digitally controlled table to test gyros, accelerometers and guidance systems. It can be supplied with a variety of digital transducers, turned by means of a worm gear 360 degrees around a tilt axis, and is automatically driven around a table axis by means of a directly coupled torque motor controlled by the digital transducer. By use of a digital control system the table can be turned at selected rates of speeds.

Circle No. 228 on Subscriber Service Card

Incremental Gaussmeter

The development of an incremental gaussmeter to facilitate research, design, testing and production in magnetic-field measuring projects has been announced by F. W. Bell, Inc. It will operate both as a conventional flux

measuring and plotting instrument and as an expanded-scale, suppressed zero meter for observing small changes in flux density. Additional features include meter overload protection, system overload indicator insuring linear operation on all ranges.

Circle No. 229 on Subscriber Service Card

Mechanical Filters

A line of mechanical filters is available from Daystrom, Inc., Transicoil Division. The unit is an integrated package containing a heavily damped two-phase servo motor, an inductive potentiometer and appropriate coupling. Although it has a servo-type mount for proper heat sinking, all inputs and outputs to the device are electrical. A voltage to the input winding results in a proportional rate of change of the output voltage.

Circle No. 230 on Subscriber Service Card

Selenium Rectifier Stack

Extending the range of selenium rectifiers to as high as hundreds of kilovolts, a compact, highly versatile pack-

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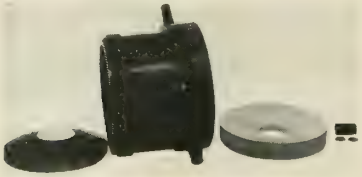
Circle No. 18 on Subscriber Service Card

SERVO IR Report

New wide-angle, high-resolution Bouwers-Maksutov infrared optical system



Another Servo-designed, high-precision system

Another Servo-designed optical system for a complex customer requirement of interest to the infrared industry, the Bouwers-Maksutov system shown above provides wide-acceptance angle and high resolution.

Glass formulation, fabrication, grinding, polishing . . . all mountings . . . optics checkout—a Servo system throughout.

Company-sponsored R&D programs are currently in progress at Servo on optical materials, infrared fiber optics, polarization, and communications systems—as well as in a number of other areas of infrared technology.

New far-infrared transmitting glasses have been discovered by Servo scientists—all of interest to the infrared optical designer.

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Circle No. 19 on Subscriber Service Card

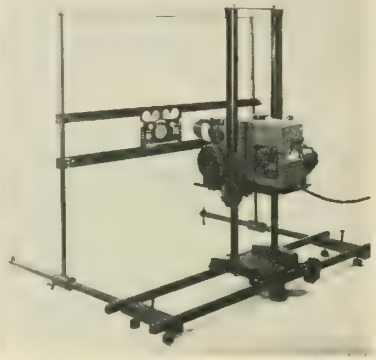
age has been announced by Radio Receptor Co. Each stack is composed of a series of flat cylindrical modules, studded together through a metallic, threaded insert in the center of each face, resembling a standard hockey "puck." These units will not replace vacuum tubes in applications requiring both high voltages and high current, but they provide unique advantages in high-voltage applications where the current demands are moderate.

Circle No. 231 on Subscriber Service Card

Meter Mover Instrument Mount

A meter mover has been perfected by Hoffman Engineering Corp., for positioning of photometers, pyrometers, cameras, microscopes and other instruments where infinitesimal precision measurements are required.

The standard unit, with component

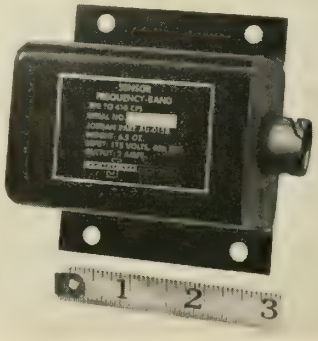


rack attachment, will hold any measuring instrument, camera or other device up to 7 lbs. maximum and 4 in. wide. It provides for movement within a cubic area 24 in. wide, 19½ in. high and 3½ in. deep, and can be securely mounted to almost any bench or table. Other sizes are available.

Circle No. 232 on Subscriber Service Card

Frequency Sensors

A frequency sensor has been developed by Jordan Electronics division



of The Victoreen Instrument Co. This device senses a preset band; when the frequency increases to the upper limit or decreases to the lower limit of the band, solid-state circuitry de-energizes the relay and thereby opens the DPDT contacts. The relay remains de-energized until the line frequency is within the preset band. The sensor outputs can be specified as either a miniature relay or a solid-state switch. Outstanding features include automatic resetting, low operating power requirement, reverse polarity protection and a wide operating range of from 20 to 220 volts ac.

Circle No. 233 on Subscriber Service Card

Quadruple-Output Power Supply

Trygon Electronics Inc., has available a quadruple-output regulated power supply. Four independent modular supplies comprise the power supply system, furnishing any combination of three different output ranges. The output current is adjustable from 50 ma to rated current output to limit the current into an overload or short-circuit condition. The short-circuit protection is fully automatic current limiting, which resets the supply automatically.

A switchable voltmeter and ammeter set is mounted on the front panel to monitor the four outputs sequentially, and each supply has its own "off-on" switch and pilot light.

Circle No. 234 on Subscriber Service Card

Concentric-Shaft Switch

Janco Corp. has announced a rotary, concentric-shaft switch featuring dual shafts. Called the Series 5-1900, it features up to 16 positions single or multipole and is designed to exceed MIL-S-6807A. The switch permits one set of poles to be rotated independently of the other set. Up to six poles per shaft, with a total of 12 poles or any combination of decks and positions are available. Being totally enclosed, it affords protection against corrosion, humidity, dust and fungus.

Circle No. 235 on Subscriber Service Card

jpl needs

Become a part of the nation's long range space explorations programs with Caltech's Jet Propulsion Laboratory. The National Aeronautics and Space Administration has assigned JPL a key role in the nation's lunar, planetary and interplanetary exploration programs. JPL is looking for the best people to fill important jobs. Here are some of them:

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SENIOR RESEARCH ENGINEERS to study combustion in solid propellants. Must have background in mass and heat transfer, 5 years experience, and advanced degree in Physics or Engineering.

RESEARCH ENGINEERS with degree in Engineering, Mathematics or Physics to study applications of solid propulsion systems to lunar and planetary exploration, i. e., effects of environments of deep space, radiation and vacuum, sterilization of propulsion systems, development of advanced propellants and propulsion systems.

PHYSICIST
ELECTRIC PROPULSION DEVICES

EXPERIMENTAL PHYSICIST to conduct laboratory evaluation, utilization studies, and research on electric propulsion devices.

M. S. or higher in Physics or Electrical Engineering with experience testing ion motors, ion sources, or other related devices.

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new literature

COAXIAL CABLE/CONNECTORS—Microdot Inc., assemblies and harnesses for miniaturized coaxial circuitry are described in bulletin A&H-1. Features of these microminiature coaxial cable and connector assemblies are light weight, smaller diameters, high operating temperatures, and convenient bend radius of the cable.

Circle No. 200 on Subscriber Service Card

TESTING AND TEST EQUIPMENT—Kearfott Division, General Precision, Inc., has announced an addition to the "Technical Information For The Engineer" series. It describes in detail the various types of tests applied to synchros, servo motors, resolvers and accelerometers to discover or verify the operational parameters and characteristics of such components. It delineates—through definitive description and supporting diagrams, equations, charts, graphs, and tables—the theory, procedures, and equipment involved in the proper performance of testing functions.

Circle No. 201 on Subscriber Service Card

HOT GAS CONTROL SYSTEMS—An article series reprint with 20 pages of design and application data covering use of hot gas reaction for aero-space vehicle control is available from Kidde Aero-Space Division, Walter Kidde & Co. Inc. The three-part booklet first describes basic considerations in choosing the hot gas system, primary applications, and an analysis of design factors and special characteristics. Design of a hot gas servoactuator is considered in the second section. The third portion covers use of reaction to control vehicle attitude.

Circle No. 202 on Subscriber Service Card

WAVEGUIDE COMPONENTS — A six-page folder describing a stocked line of high-quality cast waveguide components is available from Microwave Associates, Inc. Compensated cast bends from S through Ku-band, folded hybrid tees from S through Ka-band, E/H adapters and sidewall hybrid couplers from S through Ka-band are outlined with accompanying photographs.

Circle No. 203 on Subscriber Service Card

MAGNETIC ALLOYS AND CASTINGS—A bulletin describing magnetic materials, their properties and the facilities for their manufacture is available from the Westinghouse Electric Corp's. materials manufacturing department. The booklet contains curves and charts illustrating comparative magnetization and permeability of the various soft magnetic materials.

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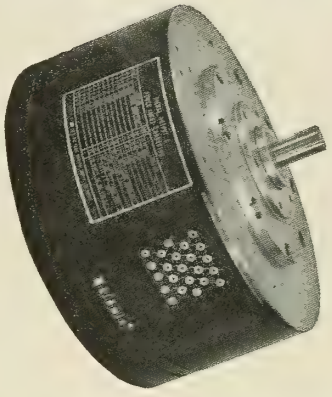
ANALOG to DIGITAL CONVERTERS



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1010	17	10
1000	16	20

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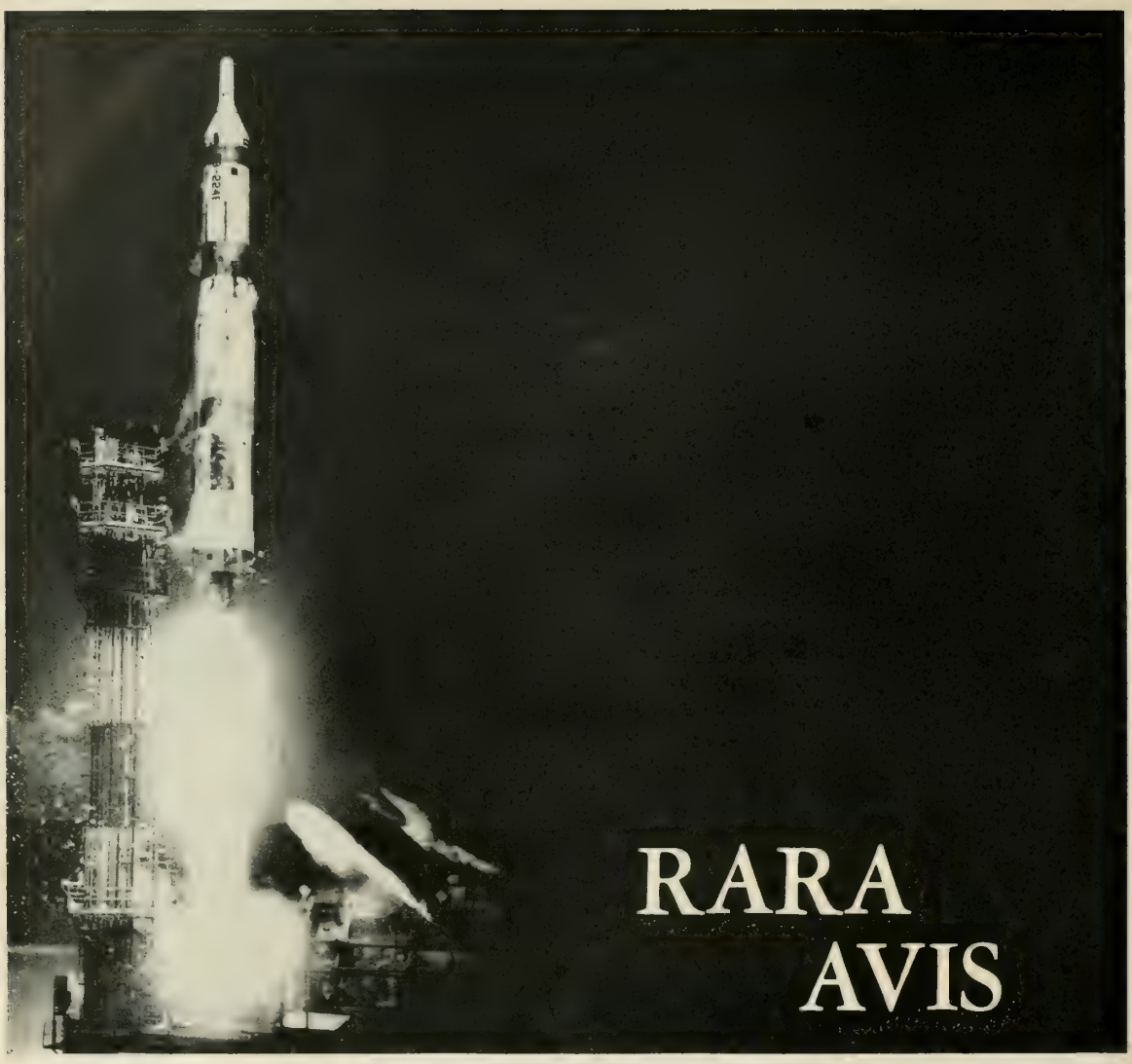
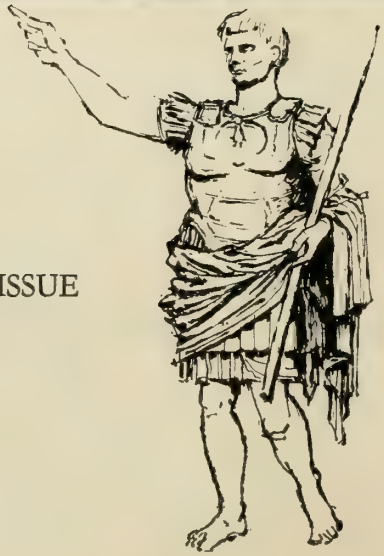


RARA AVIS



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SECOND ANNUAL
RESEARCH AND ENGINEERING ISSUE

theme: MILITARY SPACE SYSTEMS

publishing date: March 26, 1962
advertising closing date: March 5

——when and where——

FEBRUARY

Third Annual Symposium on Nondestructive Testing of Aircraft and Missile Components (Southwest Research Institute), Gunter Hotel, San Antonio, Tex., Feb. 27-Mar. 1.

Application of Switching Theory in Space Technology, symposium sponsored by Air Force Systems Command, Air Force Office of Scientific Research, and Lockheed Missiles and Space Co., Sunnyvale, Calif., Feb. 27-Mar. 1.

MARCH

Institute of Radio Engineers, 8th Scintillation and Semiconductor Counter Symposium, Washington, D.C., Mar. 1-3.

Pittsburgh Conference on Analytical Chemistry and Applied Spectroscopy, sponsored by the Society for Analytical Chemists and the Spectroscopy Society, Penn-Sheraton Hotel, Pittsburgh, Mar. 5-9.

Fifth Annual Technical Conference Society of Vacuum Coaters, Sheraton-Cleveland Hotel, Cleveland, Mar. 6-7.

Society of American Value Engineers (SAVE) Annual Meeting, Marriott Motor Hotel, Washington, D.C., Mar. 6-7.

Armed Forces Communications and Electronics Association, Cape Canaveral Chapter, symposium, Cocoa Beach, Fla., Mar. 6-8.

Flight propulsion Meeting (classified), Institute of the Aerospace Sciences, Cleveland, Mar. 8-9.

American Society for Quality Control, Middle Atlantic Conference, Statler-Hilton Hotel, Washington, D.C., Mar. 8-9.

First Microminiaturization Congress and Exhibition, sponsored by American Watchmakers Institute, Hotel Commodore, New York City, Mar. 10-13.

National Electrical Industries Show, New York Coliseum, New York City, Mar. 11-14.

1962 Symposium on Packaging of Chemical Products, sponsored by Manufacturing Chemists Association, Inc., St. Louis, Mar. 13-14.

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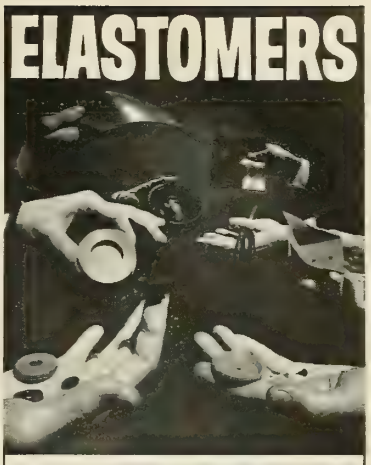

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editorial . . .

"This is Friendship 7 . . . Zero G and I feel fine . . . Oh, the view is tremendous."

—John H. Glenn, Jr.

Oh I have slipped the surly bonds of earth
And danced the skies on laughter-silvered wings;
Sunward I've climbed and joined the tumbling mirth
Of sun-split clouds and done a hundred things
You have not dreamed of—wheeled and soared and swung
High in the sunlit silence. Hovering there,
I've chased the shouting wind along, and flung
My eager craft through footless halls of air.

Up, up the long delirious burning blue
I've topped the wind-swept heights with easy grace
Where never lark, or even eagle flew.

And, while with silent, lifting mind I've trod
The high untrespassed sanctity of space,
Put out my hand, and touched the face of God.

—"High Flight," by John Gillespie Magee, Jr.

MILITARY COMMAND TECHNOLOGY... *A NEW SCIENCE FOR NATIONAL DEFENSE*

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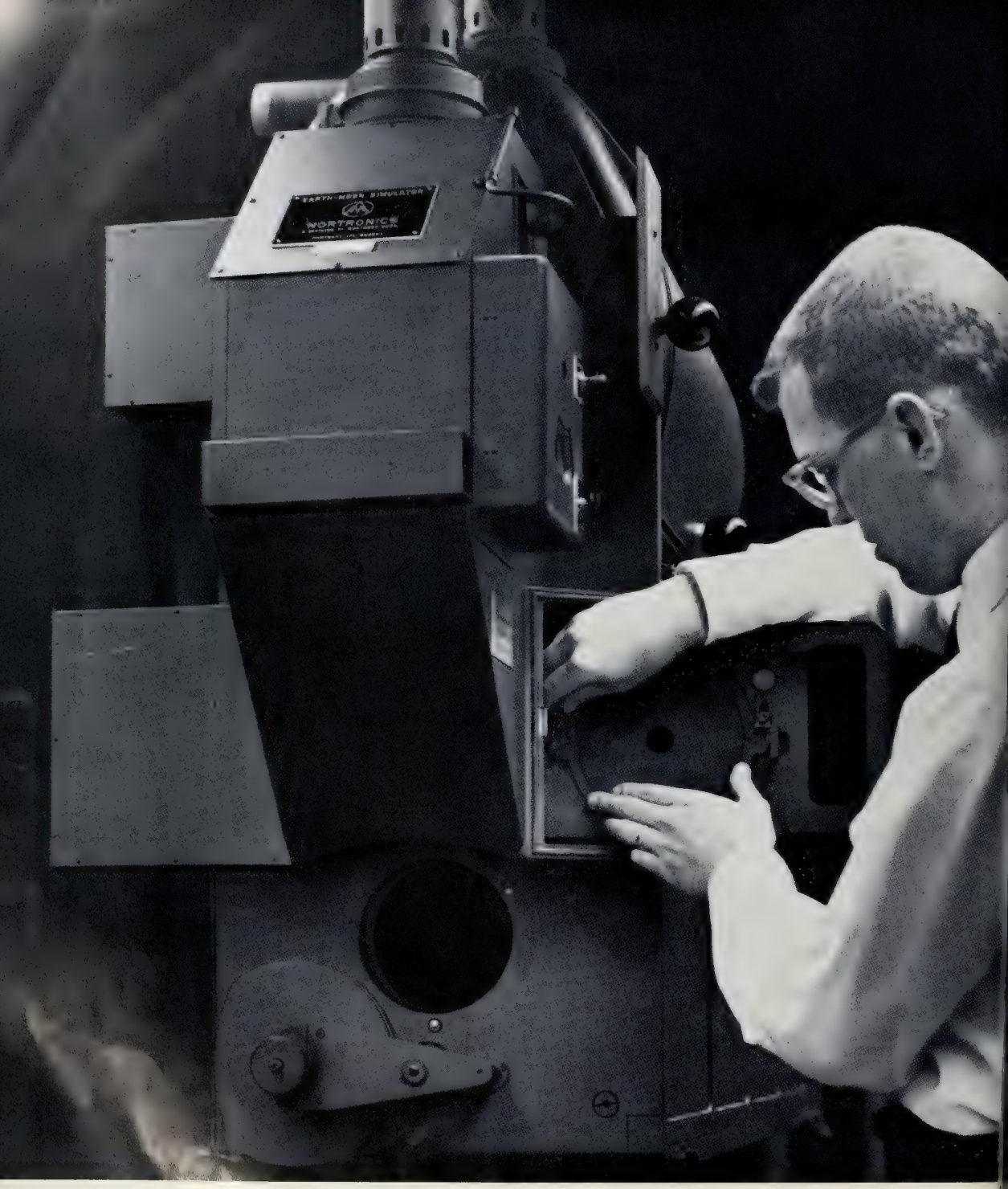

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MARCH 1962

missiles and rockets

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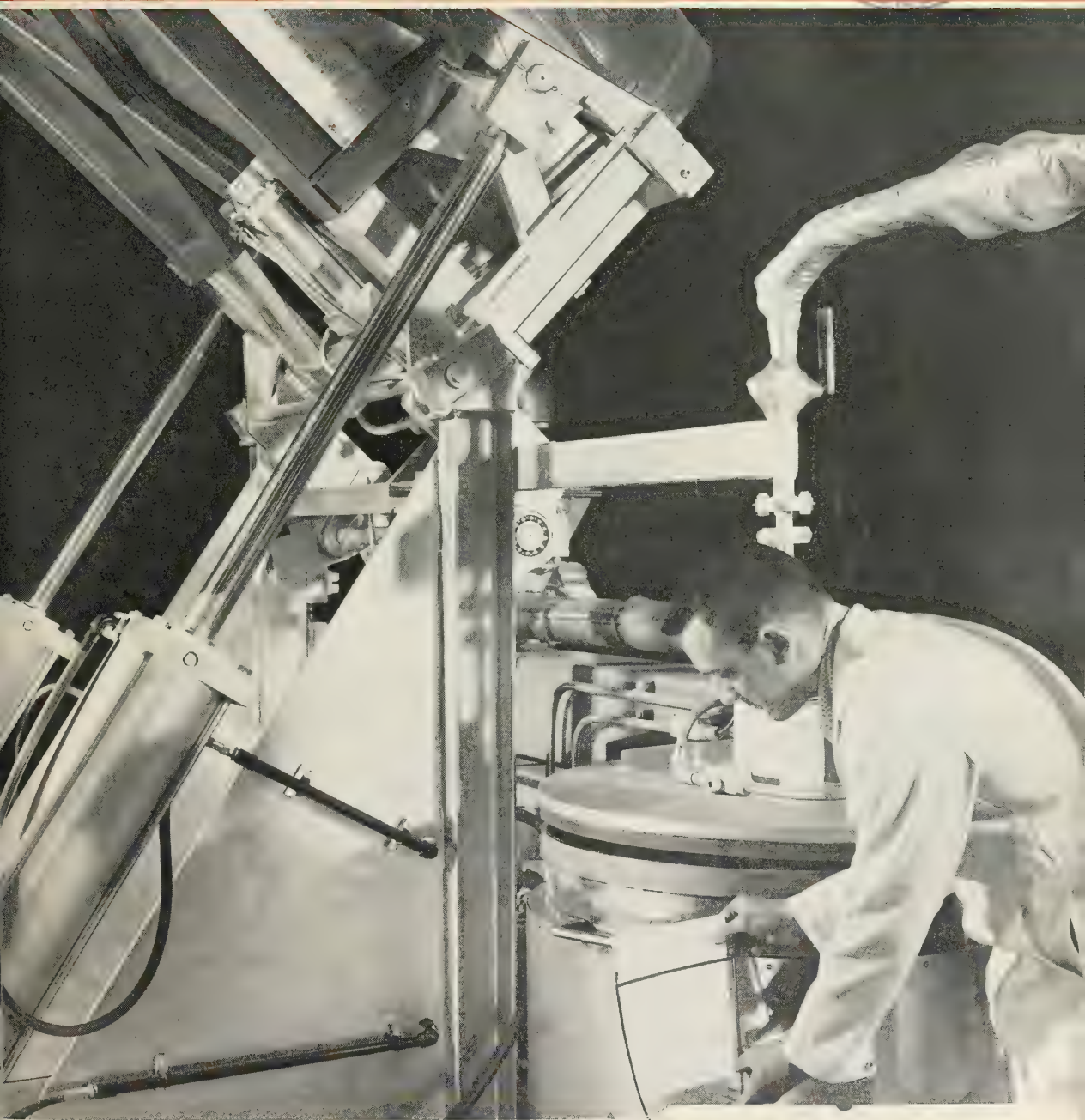

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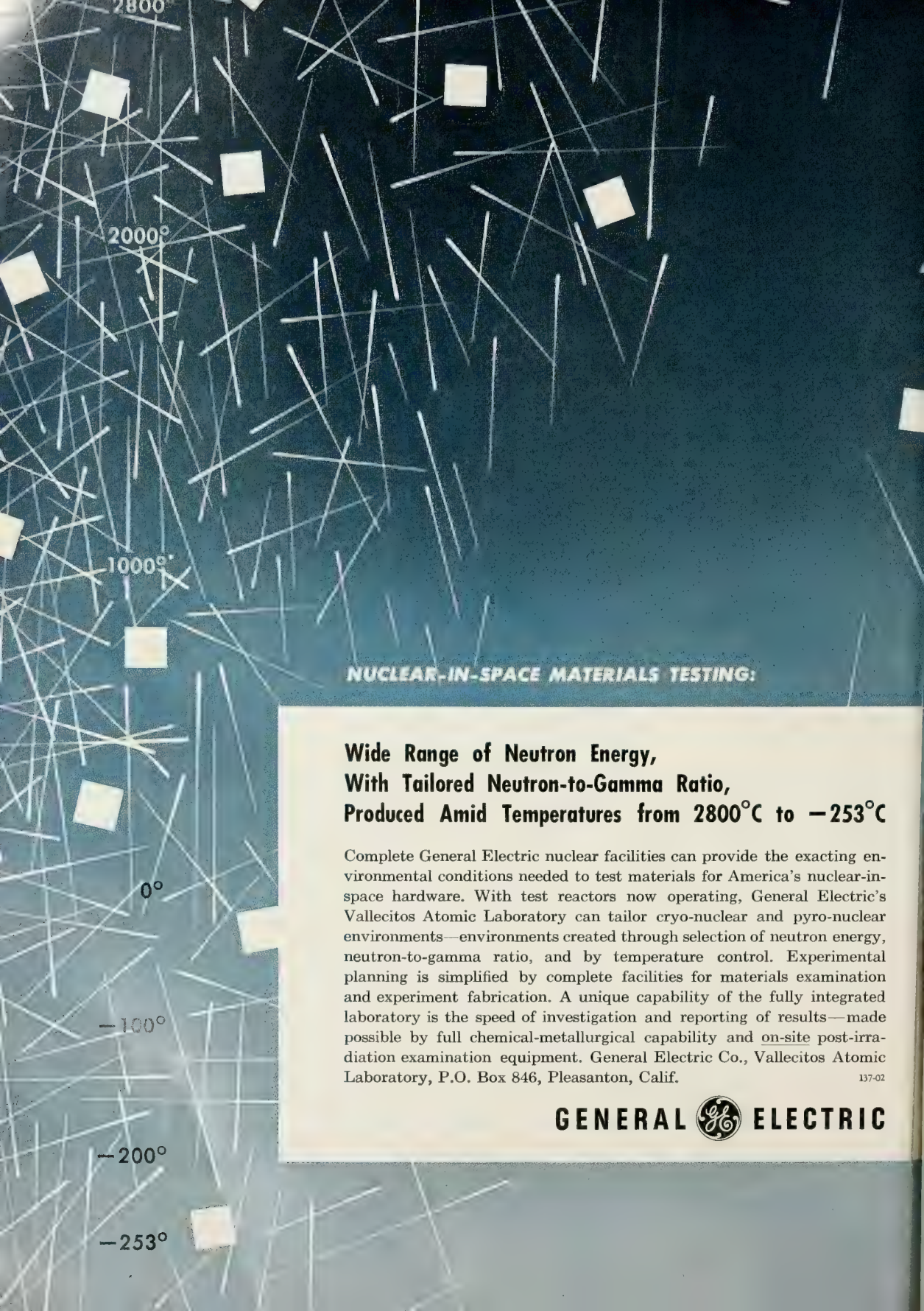

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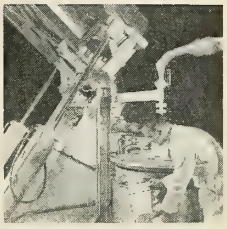
THE COVER

Ingredient log being attached to sealed premix can in automated batch mixing process to be installed at Thiokol's Wasatch Division. See story on p. 36.



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* U. S. Reg.

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Bipartisan Procrastination

To the Editor:

I have read with growing unrest the various articles, editorials, reports and stories about the stand of our government concerning development of proper superboosters for our space effort. On the one hand I see the proponents of the complex liquid boosters like *Saturn* and *Nova,* and on the other I hear the cries of the solid-fuel people that they can build flyable hardware with tens of millions of pounds of thrust within the next few years. It would appear to me that development of the solid superbooster systems would be 1) a sensible and important economy move by the government, and 2) a great jump in space technology and ability over the Soviet Union in the extremely vital field of aerospace.

Our technology in the areas of guidance, miniaturization, safety, etc., is on a par with that of the Soviets, if not ahead in some cases. Where we are lacking today is in the domain of sheer thrust—to "git thar fustest with the mostest." Getting there "fustest" is still debatable, but the "mostest" can be answered by the proper heavy booster equipment. We *know* what we want up there; if we aren't first by a little while, at least we could have the most—in quantity as well as quality.

Logically, therefore, it seems that the government could better spend a much higher proportion of its development funds on working solid-fuel booster technology. Failing this, I am sure that the government will have failed the very people whose security it represents. I am sad and a little disheartened over the political procrastination, lack of imagination, and unwillingness to take a few gambles. . . . The Wrights didn't get into the air over Kitty Hawk by hesitating, and I'll wager that the present hesitation on the part of our two-conservative-party system won't get us into space very fast, either. Let's get on the ball!

James Johnson
Grinnell College
Grinnell, Iowa

Senator Chidden

To the Editor:

In M/R, Feb. 5 was a quote from Sen. Douglas (D-Ill.) to the effect that the *Apollo* program for landing a man on the moon is still—in his mind—classified as a stunt. To back up his thoughts he refers to a poll that he has conducted in which ⅓ of the astronomers he queried—members of the American Astronomical Society—state that they feel the lunar landing is unnecessary.

I do not know which astronomers he has spoken to, but those I have heard comment—including such authorities as Gerard Kuiper, Harold Urey and Herbert Friedman—all agree that the lunar landing is more than desirable—imperative in fact—if the present astronomical theories are to be substantiated by those who will land on the moon and return to earth. Moreover, the total benefit originating in the *Apollo* program for the American public will be huge. One does not have to be very imaginative to see improvements in medicine, communications, environmental control, electronic controls and power sources, to mention a few.

The Senator's superficial investigation and resulting facetious remarks are unworthy of a member of that august body.

Saunders B. Kramer
Sunnyvale, Calif.

Further Re 'Shortage'

To the Editor:

I am a housewife, busy with balky well pumps, suds-belching washer and trying to be father as well as mother while my husband commutes cross-country on missile business.

I have read M&R cover-to-cover weekly for several years, which may seem idiotic since I have no scientific or engineering training—just a crows' nest collection of information picked up over years of encouraging and sparking the curiosity of a space-minded son (long before "Space" became "popular".)

I read your article "Scientist-Engineer Shortage Versions" and the Feb. 1 editorial "A Plan for Engineers," along with letters from Engineers, Engineer's Wife and Engineering Student, and all the worries of the past years came back, threatening to resurrect last year's ulcer, brought on trying to decide what to do with a son ready for college. I wonder if educators, and all those connected with space in every facet know what space-minded youngsters and their parents are up against—in selecting a college—and a course. I have learned we are not unique. I believe if educators and people in the industry would read this and act there could be less college failures and out-of-job workers.

Our son didn't suddenly develop an interest in space. It started when I read his first book on astronomy to him. Math has always been fun. He considered books on kinetics, rockets and trig pleasure-reading. His school grades were mediocre-to-terrible. We were told he was so far ahead of his freshman high school classmates he was bored. No one seemed to know what to do until his junior year. The school superintendent then offered him added subjects in math and science. His grades improved. Tests showed he was above average, but not a genius. He was a National Merit Finalist. He had scholarship offers from colleges across the country. Name Brand Colleges offered to start him off in second-semester or second-year courses.

But what courses? There was no doubt

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it should be in the space field, but we wanted some liberal arts, too. And none of the engineering courses seemed to fit in Space Age. Traveling around these United States, my husband had opportunity to ask engineers and others for advice. Time and again he heard "Engineers are walking the street jobless." (That's when I got an ulcer.)

After carefully sorting our meager supply of information (and advice from educators, too) we decided straight physics would be best. We chose a college nobody seems to know because the school seemed to think as we do and is demonstrating interest in training students for space age jobs. The school is one of 50 *Time* Magazine listed as "Little Known But Good." Our goal is to see this boy come out of college with something besides a sheepskin. He is an Honors Program student in a specially chosen group.

He is happy. He is learning. But was physics the right course? And will industry ask what he knows—or merely glance at the college name—when he seeks his first job? Where will he fit in or will he? He has the potentials—is that enough? Is the desire to learn and keep learning, combined with capability and dedication going to be enough? Or is the "starshine" going to be knocked out of his eager eyes because he didn't take the right courses at the right college?

Isn't there some place in the industry where he could work summers for practical experience? If so, where? Or must he continue summers as sheet metal apprentice while longing to learn all he can of space science as soon as he can? Even with a scholarship, the years ahead will be financially skimpy, demanding years for all of us. But, if he can find a place where he can help a little to add to our store of scientific knowledge, they will be worthwhile years. Will that place be open for him?

We have a 10-year-old son who seems to be following in his brother's footsteps—the house looks like a cross between a menagerie, a library and a laboratory.

By the time this one's ready for college I hope educators and industry will have decided what a budding engineer or scientist must know—and do—to fit into the changing Space Age world.

What it all boils down to is: Have I handicapped two innocent children by encouraging them to have a lively curiosity in something besides football and rock n' roll? But, can you put the public library and plans to grind a telescope lens off limits to a child bent on that course? Should I stuff them with vitamins and the seemingly popular concept of following a sheep-like, popular course which seems "softer" when I look into the future and wonder if industry will have a place for them. All I know is I am curious, too, about what's out there in space and if I had it to do all over again, I'd go against public opinion and encourage my offbeat eggheads to keep digging. That "starshine" in their eyes may bring the stars closer and make the world a little better. Now, I have a foundered horse waiting to be doctored.

Mrs. Rusdell Rood
Wichita Falls, Tex.

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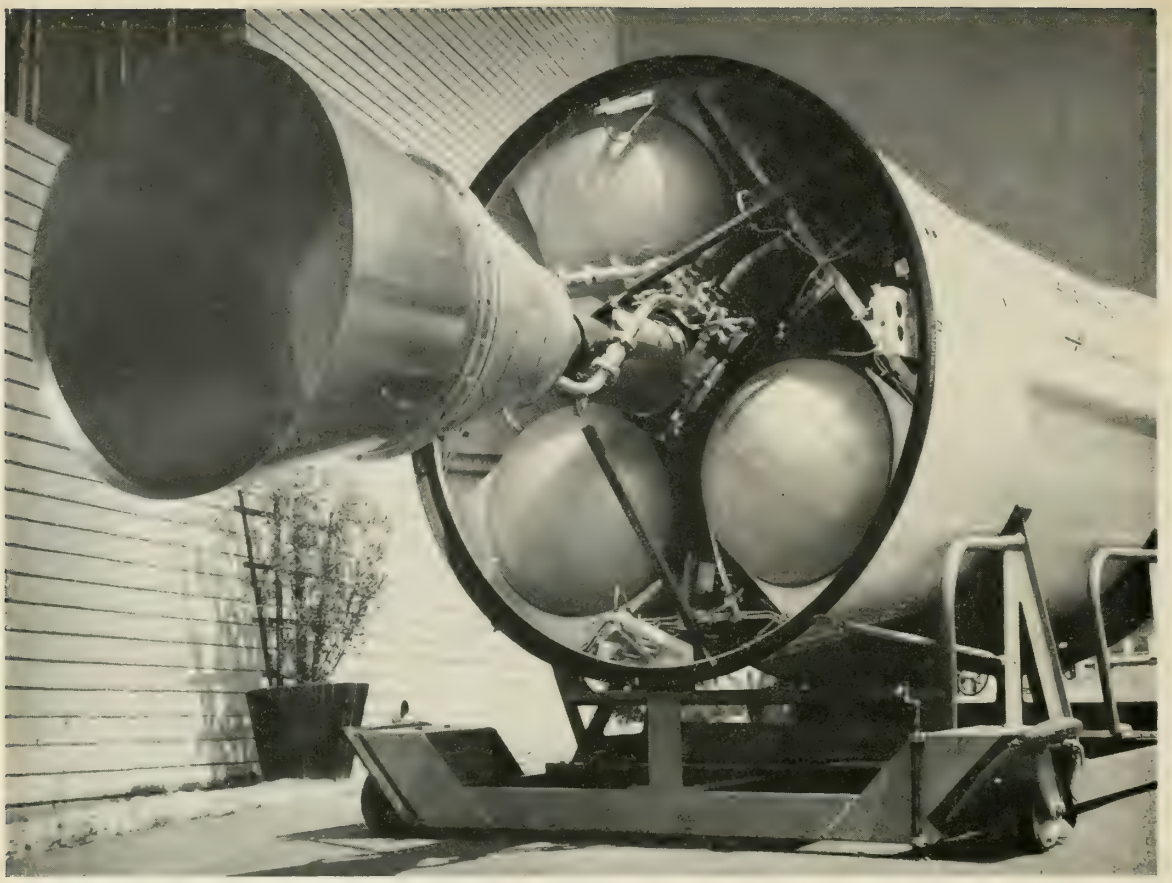

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The Countdown

WASHINGTON

New Buildup for Aerospace Plane

Increased funding for *Aerospace Plane* is provided in the FY '63 Department of Defense budget. Aimed largely at *ASP* component development, program financing is planned at a $19-million level, compared to $8-9 million in Fiscal '62. Actual step-up is not that large, however, since some *ASP* spending was unidentified in last year's budget.

Titan III Approval Not Final

Defense Secretary McNamara has not yet given final approval to the expensive *Titan III* production program. Present financing is aimed at defining the program by firming up basic design, setting up project management and carrying out preliminary analysis.

NASA Programs Under Fire

NASA will come in for some heavy cannonading this week from irate congressmen. Four subcommittees of the House Space Committee are scheduled to begin delving into details of NASA's budget request. Two major areas which will be probed thoroughly: the oft-delayed *Centaur* program and the NASA decision to emphasize liquid over solid propulsion in its large launch vehicles.

Expanding Program for Solids

Air Force plans now call for design, development and firing of solid motors in both the 156-in. and 240-in. classes, in addition to the 120-in. program. Commenting on the two larger motors, Assistant Defense Secretary John Rubel says, "We will not build a plant or embark on a big-scale program yet. But we will fire some." DOD's Fiscal '63 budget for solids: $100 million.

Recruiting Troubles at Space Agency

NASA is running into trouble in its effort to add 200 scientists to the payroll by June 30. Labor Secretary Goldberg agreed to help the lagging program with a loan of recruiting facilities in the Federal network of public employment offices.

INDUSTRY

Firing of Saturn Second Stage Set

First full-scale firing of the *Saturn* booster's S-4 second stage with two RL-10 engines is scheduled for May. There is some skepticism among NASA officials that the schedule will be met. Meanwhile, the second *Saturn* launch vehicle *(SA-2)* has reached Cape Canaveral by barge from Huntsville, Ala. Mid-April launch is scheduled.

OSO Shot Delayed After Test

Delay in the launch of the Orbiting Solar Observatory at Cape Canaveral came after tests indicated possible trouble during separation of the spacecraft from the *Delta* launch vehicle's third stage. Trouble now has been cleared up and the shot is slated to go March 6.

Bullpup Headed for White Sands

Martin Co.'s *GAM-83* Air Force *Bullpup* is headed for testing with the Republic F-105 on the White Sands missile range. Program is to be assigned to Holloman AFB shortly.

Follow that Hound Dog

Air Force is planning to fly a North American *Hound Dog* from airborne launch over Del Rio, Tex., to the White Sands missile range. *Hound Dog* recently completed tests at Mach 0.8 at 400-ft. altitude in a demonstration of low-level feasibility.

INTERNATIONAL

UN Meeting to Test Red Space Offer

First opportunity to test the recently expressed Soviet desire to cooperate with the U.S. in space exploration will come at a meeting of the UN committee on peaceful uses of outer space. Session is set for March 10. Objective: to set up a work program under the resolution adopted by the General Assembly last December.

British Hoping for U.S. Delay

Engineers working on the Goonhilly Downs facility which will be the British ground station for transatlantic communications satellites are hoping for a delay in the U.S. launching program. Official line is that the station will be ready on time for launchings of *Telstar* and *Relay*. Technicians on the job say, however, there is considerable doubt of this.

Paris Meeting on Bullpup

A meeting set for March 19 in Paris may determine the fate of Martin-Orlando's *Bullpup* as a NATO weapon. European sources see this as the future for the air-to-surface missile: Royal Navy will spend well over $6-million for 1000 *Bullpups*. These could be provided by Orlando, or a production license for *Bullpup* might be obtained by a consortium of British, West German, Danish and Norwegian firms, headed by Hawker-Siddeley. NATO's Baltic Approaches Command could order another 4000 *Bullpups* in addition to the Royal Navy requirement. Cost: $25 million.

New U.S.-French Alliance

Watch for interesting news from WELT, the new electronic tube firm established by Hallicrafters Co. and CSF of France. Full name: Warnecke Electron Tubes, Inc. Robert R. Warnecke is the developer of a unique anti-jamming electronic device for the French Air Force.

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The Missile/Space Week

Shots of the Week

It was a slow week for U.S. space shots, with three Air Force launches the sum total of activity.

A *Titan* ICBM was launched from Vandenberg AFB on Feb. 23. The shot from an underground silo proved unsuccessful when second-stage ignition failed.

The Air Force successfully launched *Discoverer* XXXVIII on Feb. 27. AF refused to disclose the satellite's altitude or the length of time it takes to whirl around the earth.

It also would not say what kind of instruments the satellite is carrying. Many *Discoverers* have carried secret gear to test equipment for *Midas* missile detection and *Samos* photographic satellites.

An *Atlas E* ICBM was fired from Vandenberg on Feb. 28 and traveled successfully on its planned 4000-mile course.

NASA Opens Budget Testimony

Associate Administrator Dr. Robert C. Seamans, Jr., told Congress that NASA will spend $2.2 billion on its manned space programs in Fiscal 1963.

Seamans testified as the House Space Committee opened hearings on the authorization legislation for the space agency's $3.7-billion budget request.

He said the manned spaceflight funds would be split up into $1.6 billion for research, development and operations, and $635 million for construction of facilities.

Earlier, Administrator James E. Webb told the committee NASA would spend $35 billion over the next 10 years.

Some $20 billion of the total would go to support Project *Apollo*.

Webb also told the committee that while Russia will probably make a manned lunar orbit flight before the U.S., this country can still make the manned lunar landing first.

He said this would be accomplished before the end of the decade —possibly as early as 1968.

Detailed testimony will begin this week when four subcommittees of the Space Committee hold public hearings.

Committee Chairman George L. Miller (D.-Calif.) said the budget would receive detailed scrutiny, "but I am sure it will be able to withstand it."

Super-Minified Unit Shown

The Air Force this week unveiled another advance in the art of solid-state systems — the super-minified electronic unit.

Westinghouse Corp., to show feasibility of the molecular-electronics systems approach, built a 16-oz. radio receiver patterned after the AF AN/ARC-63 emergency communications receiver.

Slightly larger than a pack of cigarettes, the new system is 1/10 the weight of its conventional counterpart and occupies only 9 cu. in. The ARC-63 normally requires a volume of 148 cu. in.

Performance of the two units is identical, say Air Force officials.

New Hybrid Test Success

10,000-LB.-THRUST experimental hybrid engine is successfully fired at United Technology Corp., Morgan Hill, Calif. The engine uses a solid fuel and liquid oxidizer. Four engines have been fired recently in the company-funded program.

The unit is one of a series of feasibility models resulting over the last 3 years from Westinghouse research contracts with the Aeronautical Systems Div. at Wright-Patterson AFB.

Re-use of Tower Cuts Costs

NASA's modification and installation of a used portable service power satellite launch pad at Vandenberg AFB will be completed by the end of this month.

The pad, with its rubber-tired service tower 151 ft. high, will be used for *Thor-Agena* launches of all NASA satellites which require a polar orbit.

NASA officials said that conversion of existing equipment made possible a saving of $1 million and ten months' construction time.

First launch from the pad will be *Echo II*, a 135-ft.-dia. inflatable passive communication satellite.

Rosen on Rendezvous

NASA is determined to press development of the rendezvous technique simultaneously with direct flight, to avoid possible hobbling of the U.S. lunar and interplanetary exploration programs.

Milton Rosen, director of launch vehicles and propulsion in the space agency's Manned Spaceflight Programs, said last week that the pacing factor for developing a successful rendezvous would be mastering the technique—not launch vehicle development, as is popularly believed.

Rosen spoke to a meeting of the National Capitol Section of the American Rocket Society.

Glenn Reprints

In response to reader demand for reprints of last week's editorial page on Astronaut John H. Glenn, MISSILES AND ROCKETS *is happy to offer reprints of the Feb. 26 editorial page in color, without the editorial slugline or magazine identification, on heavy paper suitable for framing, at 50¢ each. Similar laminated hard-finish wall or desk plaques, mounted on beaverboard and suitable for immediate hanging, are available at $2.25 each.*

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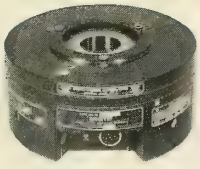

17 DIGITS DIRECT READING
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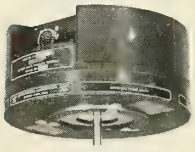

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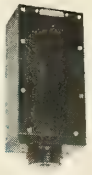

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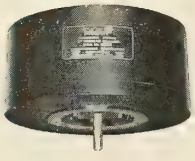

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AF Fights for Bigger Space Role

by James Trainor

AFTER FAILING to gain Department of Defense support, the Air Force has turned to Congress in its drive for a greater share of the space budget. For several weeks, top AF officials have been testifying behind closed doors on the potential military space threat and the needs of the Air Force to counter the threat.

Although most of the testimony has not been released, that which has been made available shows a coordinated, well-planned campaign by the Air Force for a greater share of the space dollar.

"Space programs," Secretary of the Air Force Eugene M. Zuckert told the Senate Appropriations Committee last week, "represent an evolutionary extension of the Air Force mission, and we are now moving into a truly critical time period."

"If we are to assure a military capability in aerospace in the future, we must accelerate the development of military applications of space technology," Zuckert said.

The Air Force views have not been supported by DOD officials. Downgrading the potential of a Soviet space threat, Assistant Secretary of Defense John Rubel told MISSILES AND ROCKETS last week: "We cannot visualize or define now a military mission for a man-in-space."

DOD has, for example, taken a strong stand against efforts to expand the *Dyna-Soar* program into a full-fledged military space project.

"*Dyna-Soar* has never been anything other than what it is now—a program for exploration of new flight regimes," Rubel said. "We don't need hundreds of people churning around on a big project."

The *Dyna-Soar* program will be similar to the *X-15* program, he explained, depending on the dedication of a small number of scientists and engineers.

"That's the kind of guidance we are trying to put into the *Dyna-Soar* program," Rubel stated. "The biggest problem is to get the word to the military and to industry."

Rubel also made it clear that plans to give the Air Force a larger role in NASA's lunar landing program (see box) will not provide for any Air Force management responsibility or direction of any portion of the NASA program.

• **Space plan developed**—Source document of the coordinated AF space drive was disclosed by Lt. Gen. James Ferguson, AF Deputy Chief of Staff for Research and Technology, in a prepared statement before the House Armed Services Committee.

The Air Force, Ferguson acknowledged, has drawn up a highly classified document, the Air Force Space Plan, which summarizes current long-range objectives and needs. The document—the so-called AF "White Paper"—also identifies "specific technological objectives for the next ten years," he said.

The plan was distributed under an endorsing letter from Chief of Staff Curtis LeMay to the whole of the AF R&D community. It provides basic guidance on the philosophy, tasks, technological problems and current status of the AF space program.

• **NASA's fine, but**—Although every AF official stresses the close cooperation between the military and NASA, they are also quick to point out that, while the space agency's programs are helpful and valuable, the problems faced by the two agencies are essentially different.

A favorite illustration of the dissimilarity—used by both Zuckert and Ferguson before Congress—is the problem of rendezvous with objects in space.

The Air Force program for rendezvous, Zuckert told Congress, "will involve techniques to contact uncooperative, hostile targets. This is a vastly greater problem, and one vastly different from the problem of making rendezvous with an accurately pre-positioned vehicle which is actively assisting in the mission."

Since intelligence estimates indicate several possible military applications of space by the Soviets, the Air Force argues that the U.S. must protect itself by developing both offensive and defensive space capabilities. In this way,

Rubel Outlines AF Role in Lunar Program

A PLAN TO GIVE the Air Force a larger role in NASA's manned lunar landing program is close to final approval.

Details of the plan to formalize cooperation between NASA's Office of Manned Space Flight Programs and the Air Force Systems Command were outlined last week by Assistant Defense Secretary John Rubel, who emphasized that the plan does not call for a joint AF-NASA program.

"NASA has responsibility for the lunar program," he said. "Neither DOD nor NASA has any desire to fuzz the lines of responsibility."

NASA will continue to provide program management and the funding, with AF providing whatever support is within its capability. Extent of Air Force participation will be carefully spelled out.

"We will not say the Air Force will support the Manned Lunar Program and let it go at that," Rubel said. "That would be a blank check."

Point of contact between the two organizations is to be a liaison office set up under Gen. Bernard Schriever at AF Systems Command, which will work with D. Brainerd Holmes, director of the space flight office at NASA. It is expected that Gen. Schriever will appoint a deputy to work with Holmes.

The Air Force lunar support effort will be centralized in the AFSC office, with other AF offices to be established by Systems Command as necessary at lower levels.

In the *Gemini* program, for example, liaison takes place at a lower level—between Marshall Space Flight Center and AFSC's Space Systems Division. Thus, the lunar program might require additional offices at Houston's Manned Space Flight Center or at Marshall.

The agreement will be sufficiently broad to take full advantage of the Air Force capability as a "subcontractor" in the lunar program, but will not be so broad that new programs can be added without authority.

"We don't want to be in a position where people in the field have to come to a high level for every decision," Rubel explained. "That places management too high—at the policy level. At the same time, we don't want working people making policy."

it is asserted, the U.S. can assure that all nations remain free of space domination.

"Only then," Zuckert declared, "can we pursue the opportunity to probe the physical mysteries of space, to find the methods of employing it, to bring to reality the equipment in which we can explore and operate in space, and to participate fully in the conquering of the vast space beyond our world."

• **What does AF want?**—From the arguments advanced by Air Force officials before Congress, it is apparent they feel the distribution of the space budget—some $5.5 billion for FY '63—is inequitable.

As one AF official told M/R, the total funds for space exploration are unlikely to grow very much over the next couple of years. The Air Force, therefore, would like to see a more equal distribution of the money between military and civilian space exploration.

However, in presenting the FY '63 budget to Congress, Assistant Secretary of Defense Charles Hitch revealed that the largest single increase in R&D spending was in the area of military astronautics.

The spending for military space programs, he said, "will rise to $1.4 billion, about $300 million over the current year and more than $600 million more than 1961."

NASA's budget far outstripped this increase. The space agency is expected to receive $3.7 billion—largely to support the manned lunar landing program.

Reportedly, the major stumbling block to an expanded Air Force role in space is Secretary of Defense Robert S. McNamara. He is said to feel that the Air Force has not proven that a substantial military mission in space exists—particularly a mission that would require manned spacecraft substantially different than those being developed by NASA.

• **Space systems outlined**—Beyond the immediate need for geodetic, early-warning, navigation, communications and meteorological satellites, Gen. Ferguson told the congressional committees the AF sees a requirement for an advanced aerospace craft capable of "self-contained flight to and from space," and possibly manned space stations.

Other future applications, he added, will include improved systems for attack warning and nuclear test detection, as well as possibly providing "a breakthrough in the area of ballistic missile attack."

• **Eleven problem areas**—Much of the technology required for these advanced space systems, Ferguson said, has yet to be developed. The AF, therefore, has undertaken "a series of closely related efforts . . . both to exploit the earlier military space applications and, at the same time, to expand our capabilities in several well-defined areas of technology."

The eleven areas in which the AF is concentrating effort are:

—Launch Vehicles: "working toward increasing the thrust of chemical boosters and bringing forward the technology of nuclear rockets in anticipation of . . . their greater potential for longer endurance and reduced cost per payload-pound in orbit."

—In-Space Propulsion: ranging from low-thrust devices (electrical propulsion) and high-thrust, chemical and nuclear engines for in-space interception and maneuvering.

—Bioastronautics Equipment: early data will be provided by the *Mercury* program. However, the AF is interested in how well man can function in space for longer-duration missions and for operations through the Van Allen Belts.

—Environmental Data on Space: AF will depend to a large extent on NASA for this type of information. However, the requirement for continuous operation, for example, makes especially critical the need for solar-flare forecasting.

—Rendezvous, Docking and Transfer: Although NASA's *Gemini* program and the AF Satellite Inspector Program are expected to furnish much of the information required, the AF must develop the capability of rendezvousing with hostile satellites.

—Power Supplies: especially interested in power supplies for long-duration, high-power systems of several hundreds of kilowatts. The *SPUR* program is expected to demonstrate such a power supply in the later 1960's.

—Sensors: technology has been advancing at a rapid pace. A large portion of AF applied research projects are devoted to improved infrared sensors, higher-resolution photographic cameras and improved radars.

—Communications Equipment: there is need for an integrated secure system of military communications which will operate reliably under any anticipated condition including the presence of interference—man-made or natural.

—Re-entry and Recovery: specific need is for techniques permitting selective, conventional aircraft-type landings within the largest possible geographical area and with subsequent re-use of the vehicle after a minimum refurbishment.

—Weapons Technology: investigations are being conducted on the feasibility of new weapon concepts.

—Command & Control: the AF is presently restricted to an applied research program in this area. However, the need for positive control in space imposes many challenging problems.

• **Support expected**—From recent statements by members of both houses of Congress, there appears to be strong support for the Air Force position.

Many congressmen and senators are reported to feel that, unless there are distinct military advantages to be gained from the manned lunar landing program, the estimated $50-billion 10-year program is not worth the money. ⌘

LeMay Wants Far More Minuteman Funding

FUNDS SHOULD be provided for at least 100 more *Minuteman* missiles, together with authority to procure long-lead-time items for 150 more, Air Force Chief of Staff Curtis LeMay told a Senate Committee last week.

In the first public disagreement over the FY '63 defense budget, LeMay also warned against a downhill trend in spending over the next four years for Strategic Retaliatory Forces.

Noting that the 18% of the defense budget now spent for retaliatory forces may decline in the next four years to 8%, the AF chief commented, "I don't think that we can maintain strategic superiority with that."

Air Force Secretary Eugene M. Zuckert, appearing with LeMay before the Senate Military Appropriations Subcommittee, also took issue with the Administration's decision to terminate the XB-70 program once the feasibility of the project has been proven.

In reply to a question by acting subcommittee chairman, Willis A. Robertson (D., Va.), the Air Force Secretary said he had recommended that "the B-70 be developed as a full weapons system."

Secretary of Defense McNamara, in an earlier appearance before the committee, had said that the '63 budget had the support of the service chiefs.

In keeping with Department of Defense policy, both Zuckert and LeMay supported the budget until they were asked specific questions on programs. Then the illusion of a united DOD budget effort was shattered.

Although funds are requested in the FY '63 budget to provide a total *Minuteman* force of 16 squadrons with a total of 800 hardened missiles, Gen. LeMay expressed dissatisfaction with the buildup.

The Air Force Chief of Staff recommended that funds for the solid-propellant ICBM be increased to provide 300 missiles in FY '63—rather than the programed 200. Together with his request for items for 150 additional missiles, this would give a total *Minuteman* force of 1050—250 more than presently planned.

NASA Soon to Train New Group of Astronauts

As many as 10 men may be selected for accelerated manned flight program; Glenn reports to congressional committees

by Hal Taylor

NASA WILL ANNOUNCE in the next few weeks a new astronaut training program for manned space flights to take place every 60 or 90 days for the next several years.

The imminence of the program was disclosed by NASA Administrator James E. Webb during a round of congressional appearances with Astronauts Alan Shepard, Virgil Grissom, and John Glenn.

Final details are now being worked out. It is expected that no more than 10, and probably fewer, new astronauts will be needed. The prime requirement will be for pilots with jet experience and pilots from all military services will be considered.

There is also the possibility that civilian test pilots will be included. The new astronauts will initially be used in Project *Gemini*. Later scientific personnel may be included in Project *Apollo* crews.

The hearings by the Senate and House Space Committees also shed new light on other aspects of *MA-6*—America's first successful manned orbital flight on Feb. 20—and the U.S. manned space flight program.

Col. Glenn declared that in the future, "it is not going to be necessary to make a completely unmanned automatic advance flight before each orbital mission."

He also declared that while very little specific scientific information was obtained during the flight, it did prove how capably man can operate in space. This means, he continued, that with more data analysis and evaluation, "we probably can in the future get by with considerably less automatic systems than have been required in the past."

It was also reported that:

—NASA would be making manned space flights every 60 or 90 days for the next several years. Four more, or a total of five three-orbit missions, are planned. "I believe myself," Webb said, "that the judgment will be to conduct all four of them this year."

—Glenn's performance during *MA-6* established that the star navigation system can be used by spacemen to travel to the Moon. Shepard said that the system had proved feasible. "As a result," he said, "we intend to use the age old navigation method on the way to the Moon."

—The two-man *Gemini* program will permit two men to fly together, permit one man to fly with an instrumented chimpanzee or other animal, or one man to fly with a biopack which will enable him to change medical experiments during the flight.

—Shepard declared that he feels that NASA should have its own life science capability for manned space flight even if this duplicates DOD facilities and capabilities. "We need the support of a life sciences group," he said in referring to Project *Mercury*.

—The still unexplained luminous particles which Glenn saw during his flight appeared at the exact moment that the first sunlight was encountered during each orbit. Glenn said that "they did not appear to be coming from the capsule." He said that the smallest were "pinhead"-sized and the largest about ½ in. in diameter. They were spaced 6 to 10 ft. apart.

• **New vests planned**—Special radiation protection is being designed for the command post of future manned spacecraft and radiation vests also are being developed. Glenn said that the fact that his body responded without ill effects to his 4-hour, 56-minute flight did not necessarily mean that longer space trips might not be harmful.

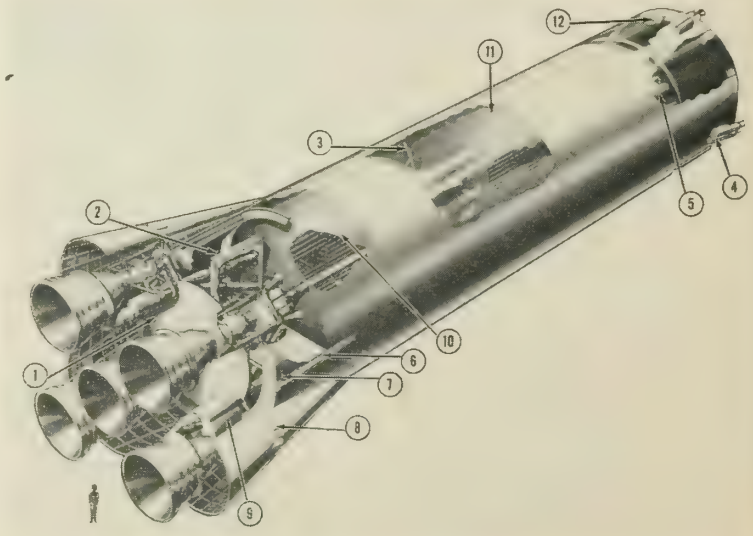
Glenn said that one of the most important findings from his three-orbit flight was that man, not machine, is the world's best computer.

He said that the fear originally was that the pilot in orbit might black out or suffer other physical failings, and that his capsule was so instrumented that no matter what happened to him the mission could have been successfully completed and the capsule brought back to earth safely.

Glenn also indicated that future astronauts should be about the same age as the current seven were when they started three years ago.

As far as the new program is concerned, NASA officials said the new astronauts will follow about the same training schedule and system that was used to prepare for the *Mercury* program.

There was a report that NASA might consider the five pilots recently graduated from the Air Force's Astronaut School for inclusion in the new group. An informed DOD source said, however, it is very likely that these men will not be available because of other duties.



FIRST NASA DRAWING of Advanced Saturn booster shows: 1. heat shield; 2. LOX fill; 3. fuel vent; 4. retro rockets; 5. diffuser; 6. hold down; 7. fuel fill; 8. air scoops; 9. engine heat shield; 10. fuel; 11. LOX; 12. instruments.

Glenn Foresees Less Complex Capsules

(The following is an edited text of the Feb. 23 press conference held by Astronaut John H. Glenn at Cape Canaveral following his three-orbit Mercury flight on Feb. 20.)

I'M VERY HAPPY to report no ill effects from Zero Gs.

It was very pleasant as a matter of fact and I had no tendency to particularly overreach switches or have any trouble with the controls as a result of Zero Gs—indeed, a very, very pleasant experience.

Someone told me last night after I had been talking so enthusiastically about this that I was an addict to it and I think I probably am. It's a wonderful feeling.

Camera Stays Put

Some of the things that happened under Zero G sort of demonstrated how fast a human being adapts to this situation. I had this little hand camera in my hands and when I had taken a picture and I wanted to do something with the switch immediately, it just seemed natural at that time after I had been weightless for I guess a half hour or 45 minutes I had acclimated to this rapidly enough and it just seemed perfectly natural rather than to put the camera away, I just put it out in mid-air and let go of it and went ahead with the switch position and reached back to the camera and went on with the work.

Under this Zero G condition, of course, it would be easy to lose different items, have them get away and get out of reach some place. As far as I know there was only one item that got lost and that was a little can of film that I got out and was going to put in the camera. And I let it slip out of my fingers and went to grab for it and instead of clamping on to it I batted it and it went sailing off behind the instrument panel and I think that was the last I saw of it.

Eating experiments—we had planned to do some of that. We'd tried this before on some of the weightless flights in the airplanes, simulating weightlessness for a minute or so, and it hadn't appeared to be any big problem. However, we wanted to try it. And I did. I had one tube of food that was—that I squeezed into my mouth out of a tube—and this presented no problems swallowing or getting it down at all.

I think the only restriction probably to food will be that it not be of a particularly crumbly nature like crumbly cookies that have little particles to them that might break off and you wouldn't be able to get all these back unless you had a butterfly net of some kind, I guess.

Speed Relative

Speed sensations—I've been asked repeatedly since the flight about the sensation of speed. Speed, of course, is relative. If you're in a complete—if you have nothing to refer to, you could be going almost any speed and you wouldn't have any sensation of it.

I think the nearest I can come to it, is ah—most of you have flown on jet airliners or have flown in jet airplanes at 30,000 feet or so and I think the feeling of speed is about the same as flying in an airliner such as that and looking down at clouds, say maybe at a height of say 10,000 feet below you.

It was very noticeable. Over a good part of our track, there were clouds of one type or another. They obscured some of the areas we wanted to look at. Part of the Western United States, down across Northern Mexico, large—almost the whole Pacific—was covered by one type cloud or another.

First, coming down Australia, Australia was always in the dark so we never could see Australia although we could see lights from the city of Perth. Cities around Perth, too.

The sunset was probably the most impressive thing you would see in orbital flight.

These were very brilliantly colored hues and the colors stretch out from the sun to the horizon. The horizon stays light for, I would estimate, some four to five minutes after sunset, which I found rather surprising because I thought the darkness would come on much more rapidly than that.

Those 'Fireflies'

And this would bring us around to a sunrise. This turned into a pretty interesting area each time around, I think as most of you are aware. At first light of sunrise—the first sunrise I came to I was still faced back toward the direction which I had come from with normal orbit attitude and just as the first rays of sun came up onto the capsule, I glanced back down inside to check some instruments and do something and when I glanced back out my initial reaction was that I was looking out into a complete star field. The capsule had probably gone up while I wasn't looking out the window and I was looking into nothing but a new star field, but this wasn't the case, because a lot of little things that I thought actually were stars were actually a bright, bluish green about the size and intensity of a firefly on a real dark night.

And these little particles that were outside the capsule were—I would estimate—some 6 to 10 feet apart, and there were literally thousands of them. As far as I could look off to each side I could see them. I could see them back along the path. Later on I turned around so that I was facing the direction from which they appeared to be coming and although, in that direction, toward the bright sunlight of the dawn most of them disappeared, you still could see a few of them coming toward the capsule.

I was moving very slowly through this field—I estimated that my velocity through this field was some three to five miles per hour. They did not seem to be emanating from the capsule. They appeared to have even distribution on each side of the capsule. I thought of two things that they might be initially. One was the cloud of needles that the Air Force put up some time ago and that appears to have disappeared somewhere. I thought that we had suddenly found them again. But they didn't look like that—They didn't look like they had any length to them at all. The other thing I thought was perhaps that—as we use our hydrogen peroxide jets—the hydrogen peroxide decomposes into steam and oxygen and comes out under high heat pressure. And I thought perhaps this water vapor was turning into little snowflakes and the luminous light from the sun was causing them to fluoresce for some reason or other. But when I would work the thrusters on the capsule, this did not appear to be causing any snowflakes or anything like it at all.

So all I can say about these is that I saw them from about the first light of sun to a period of three and a half or four minutes. That time period made close observation of them possible. Occasionally, one of them would come drifting by the capsule window very close in the side from the sun and at that time they would look like very small white particles. And they would vary in size from maybe pinhead size to something say about three eights of an inch in diameter, or that order.

Some Problems

We had some problems during the flight. The automatic stabilization and control system was causing some difficulty. It didn't appear to be correcting up the way it should. I was able to use the manual control during that period and this appeared to—it didn't cause any trouble at all. It seemed very natural to take over manual control after all of the trainer work we've done. Trainer simulations, incidentally, were very, very close to the orbital control situation. This was particularly true in the fly-by-wire mode where we control through the automatic thrusters. When we started having this problem at the end of the first orbit, I was largely on manual control from there on until the end of the flight.

The other observations that we had planned to make had to go by the boards, while I tried to work out the control system problems, and I spent most of the last two orbits working on this and making

some other observations, largely concentrating about 90 per cent of the time on the control system.

Ground, as most of you probably know—the ground telemetry receivers had picked up an impulse that I possibly had a loose heat shield. And for that reason it was deemed advisable to keep the retropackage in place during re-entry so that it would go ahead and burn off and by that time we would be in a high enough aerodynamic force field to keep the heat shield in place, in case it was, in fact, loose.

This made pretty spectacular re-entry from the capsule standpoint because as the retro package—as I retained the retro package and entered into the first part of the high heat area of the re-entry, the straps on the retro pack broke loose and I felt a bump on the capsule and thought that the retro package had jettisoned as it was supposed to do. Apparently this was not true, but I thought so at the time. As I went into the higher heat this glow picked up. Outside the capsule was sort of a bright orange flow outside the window.

It became apparent that something was tearing up on the heat shield end of the capsule because there were large pieces—anywhere from pieces as big as the end of your finger to pieces probably seven or eight inches in diameter—were breaking off and falling off the edge of the capsule and coming up back past the window, and were flaming very brightly. You could see the fire and the glow from them as they could come back up past the window.

Well, this obviously was the retro package burning up and breaking off as we knew it would if it had been retained. I thought at that time, however, that the retropackage had already been jettisoned. So there were some moments of doubt whether the heat shield had been damaged and whether it might be tearing up itself and this—this could have been a bad day all the way around if this had been the case.

I understand there was some misconception also when we referred to this term blackout during re-entry, and I was questioned aboard ship as to how I had survived the blackout and when I regained consciousness, and a few things like this, and this was—when we referred to blackout during re-entry, a communications blackout is what we were referring to in this case. And we probably should reterm this a "comloss," or something like that, so that we don't confuse it with a blackout of the astronaut involved.

This is due to high ionization around the capsule and makes it impossible for the radio frequencies that we're using to get in and out from the capsule.

G's during re-entry got up to about 8. Parachute functioned in completely normal fashion. The destroyer Noa was close by and had me spotted and came over and made an excellent pick-up of the capsule.

It came aboard and at that time I had been heated up enough and had been sweating very profusely long enough that I decided after taking the panel—the right side of the panel—down, preparing the egress out through the top, I decided at that time, since we were already on deck, that it was hardly worth the effort and I should get on out and be comfortable, so I did.

We blew the hatch on the side, after checking to see that everyone was clear outside and come on out through the side hatch.

I think, perhaps, the difficulty that we had and the action I had to take may actually have been a blessing in disguise in one way, because it showed when we had to that a man can take over control of the various systems and operate manually and still know what he's doing and not have any ill effects in this regard from Zero G.

And probably, if sufficient study of our records from this flight warrants it, we probably can go on some future flights with considerably less automation and less complexity, we hope, as a result of some of the things that we learned on this flight.

Q. Colonel Glenn, what changes are you going to recommend in the capsule's control for Deke Slayton's flight?

A. Well, before we make any positive statement like that as to the exact recommendations for future flights, we need to do a lot more looking into records and data and get all the tapes back from the various stations around the network and we have several weeks' work to do just sitting down and analyzing the data.

Q. Colonel Glenn, what did the stars and the earth look like up there?

A. Well, stars—I was a little bit surprised. I think I maybe expected to see the stars in greater quantity and greater numbers than I had seen them before. The nearest thing I could compare it to and did compare it to during debriefing was the—I think—if you've been out in the desert on a very clear brilliant night when there's no moon up and the stars just seem to jump out at you, that's just about the way the stars look.

Q. Colonel Glenn, when did you know that you had a possible emergency on your hands and how concerned were you about it?

A. You mean the retro rockets?

Q. No, the heat shield problem . . .

A. I don't recall the exact time that I knew about it. I knew about it for some time in advance of the retro sequence. I can't pin a time to it exactly. I didn't really contest this decision from the control center, because I knew that the experts we had on the ground had certainly thought this thing out much more thoroughly than I could in flight to make the recommendation that they could make.

So, while it was of some concern, of course, because it was a malfunction . . . we never have had a capsule re-enter with a retro-pack on it before. Something untried like that you look at it with a—a little bit askance maybe before you try it, of course, so there was some concern about it.

I think the major concern when these chunks started breaking off during re-entry and I could see them going back by the capsule. This was a period when I wasn't sure whether it was a damaged heat shield beginning to break up. Obviously, it was the retro pack.

Q. Could you tell us some of the things you saw on earth during the course of your flight?

A. It's all very spectacular from up there. You can see a tremendous distance. You're up above the atmosphere. You see this little horizon band of very brilliant blue color even on the day side.

Certainly one of the most beautiful things is to be on the dark side with the full moon out and see this coming off the clouds down below.

And then running over and seeing the very sharp demarcation line where the stars keep coming down below the horizon. It's interesting to note that your sunsets and the stars moving down behind the horizon occur at approximately 18 times their normal speed. This makes for a pretty speedy sunset . . .

You can see different patterns in the ocean currents, like the Gulf Stream. You can see on the earth—one area that I could observe very clearly was the area northwest of El Paso.

And that's an area where there's a lot of desert with a big irrigated area that comes down a valley northwest of El Paso and that stood out very much. You can see the squares of the irrigated areas from this distance.

Q. Do you agree that future Astronauts may need much less physical training than you and your colleagues?

A. The question was the remark that Bill Douglas made about the condition I came back in, he'd have been willing to send his wife and son along, and did this mean that we probably could do with less physical conditioning in the future. Well, I would have been very happy to have had Mary and Mike along, but it was a little bit crowded. But as far as lessening our physical training, I don't think so. You don't know what you might run into on future flights and we certainly would not want to make a categorical statement that because we had this one successful outing we would never run into any more strenuous things physically than we ran into this time.

Q. In the future, we have planned to experiment with a so-called rendezvous or docking technique in space and it's going to be important to know how your depth perception is in space. Did you have any trouble figuring out just where the booster was when it started leaving the . . .?

A. No. This was quite a sight. Right at turn around the capsule separated from the boosters—turn around and as it swung around, the booster was sitting there probably within a hundred yards. Very visible, very clear. We talked about this during debriefing. If I had the capability of having a little thrust to move over that direction, could I have maneuvered toward it? I think very definitely you could. I don't think this would be any problem at all from that distance.

I think you're always going to have a reference point of sorts. It may be stars or it may be an artificial horizon that you have set up at a certain gyro angle, but I don't think you're, in effect, you'd be saying you couldn't rendezvous as a blind person. And this is true. I think you'll always have some reference, although. I don't think you'd be completely without reference. ⁂

At Senate hearings . . .

Nuclear-Powered ComSat Design Shown

THE RADIO CORPORATION of America is designing a nuclear-powered satellite which would provide up to eight times more communications channel capacity than current first-generation systems.

Dr. Elmer W. Engstrom, RCA President, told a Senate Space Committee hearing on commercial communication satellite system legislation, that the new spacecraft would be 51 ft. long and weigh 6000 lbs. He said the satellite could be ready by 1966.

Meanwhile, quick congressional consideration of the legislation was assured as the House Commerce Committee announced that it will open public hearings on March 13.

As the hearings opened, there were strong indications that the Administration plan for a broadly owned private corporation will have a tough row to hoe in Congress.

Dr. Engstrom surprised members of the Senate committee when he told them that RCA supports the Kennedy Administration proposal (M/R, Feb. 12, p. 17), but will not invest any money in it—at least for the near future.

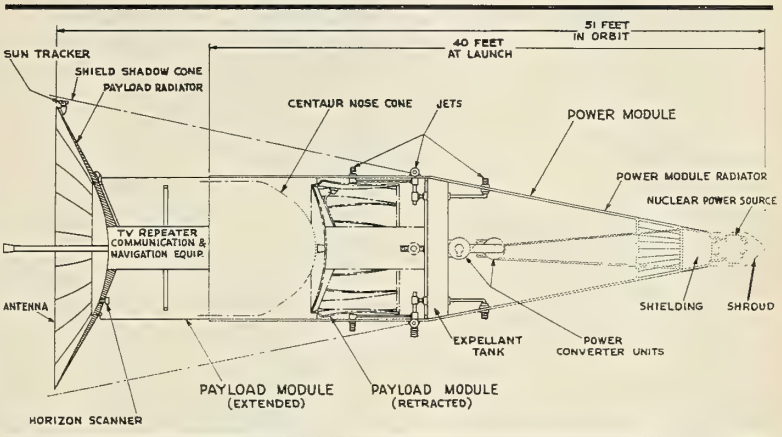
Engstrom said a future decision, perhaps in six months or a year, would be based in part on whether RCA could own ground stations necessary to the system. This is not provided for in the Administration bill.

The RCA executive indicated that while he supported the bill, he thought it was premature. He said that the system is technically, but not economically, feasible at this time.

Committee Chairman Robert S. Kerr (D-Okla.) attacked a provision of the Administration bill which would give the State Department responsibility for conducting negotiations with foreign communication carriers that wanted to use the system. He told a Department witness that "you will have as much control as if the government owned it."

Later, Chairman Newton N. Minow of the Federal Communications Commission said he favored legislation introduced by Kerr which would limit ownership in the corporation to established common carriers such as the American Telephone and Telegraph Co.

• **NASA backing**—Dr. Hugh L. Dryden, deputy NASA administrator, told the committee that prolonged public vs. private ownership debate would likely cause a slow-down in development of a communications satellite system. He said he appeared "in support of the Administration's position of private ownership."



PLAN FOR NUCLEAR-POWERED satellite proposed by Radio Corp. of America.

He discounted a question raised by a recent Senate Space Committee report that the ComSat program would place unusual demands on available boosters and launch facilities. The report urged the consideration now of expanding facilities to avoid conflicts with other space programs. Dryden said there would be an adequate supply of boosters for orbiting low- and medium-altitude systems.

The NASA official estimated conservatively that it would take five years to launch a workable global system. He expressed confidence that it could be done, though the necessary hardware has not been developed.

He said that there was no question of the need for space communications. Since 1950, he continued, transatlantic phone calls have doubled. He added that they will grow five times again in the next decade.

Milton J. Stoller, acting director of NASA's Office of Applications, disclosed some new details on the space agency's follow-on low- and medium-altitude satellites during his testimony before the committee.

He said that the advanced low-altitude satellite—similar to the current *Relay* series—will weigh about 600 lbs. The launch vehicle which will be used will be the *Atlas-Agena B*, and it will be boosted to 6000 miles and perhaps as high as 12,000 miles.

Three launches are scheduled to be made in 1964. The advanced system will have an increased capacity of four TV channels or its equivalent in telephone channels. The satellite will also be earth-oriented, to take advantage of the improved performance of directed antennas. By increasing the altitude in orbit, the time available for transmission between a pair of typical ground stations will be increased by some 25%.

Compared to the current *Syncom* capacity of one channel, the advanced high-altitude system would also have four TV channels. The follow-on satellite will weigh 500 lbs., many times heavier than the current *Syncom* weight of 55 lbs.

It will also be boosted by *Atlas Agena B* to an altitude of 22,300 miles. Two launches are scheduled in 1964 and one in 1965.

• **The most**—The nuclear-powered satellite proposed by RCA would, however, be the "daddy" of them all.

The satellite would be boosted to a 300-mile parking orbit by a launch vehicle such as the *Atlas-Centaur* and the *Titan-Agena*. From the 300-mile orbit it would be raised to its 22,300-mile synchronous orbit by electric propulsion.

The electrical propulsion units would be operated by the 60-kilowatt atomic power supply to provide about one lb. of thrust, sufficient to move the satellite to desired altitude in 60 days. ⌗

In study by GE . . .

Basic AF Spacesuit Described

by Heather M. David

THE AIR FORCE has released first details of a study that will be the basis for redevelopment of all suits to be worn inside and outside AF space ships.

The report, parts of which are still classified, gives an indication of what the Air Force is planning in the way of space missions: it calls for a garment which can be worn outside a vehicle in a circular orbit at altitudes of from 300 to 500 n. mi., during a mission lasting from two to five months.

General Electric's Missile and Space Vehicle Department carried out the study under the project name SPACE CAPE (Complete Anthropomorphic Protective Enclosure). The department made recommendations for design but did not develop an actual spacesuit.

The type of suit studied is to be worn for no longer than four hours outside the vehicle (while making repairs, etc.) and eight hours inside. As the word "anthropomorphic" indicates, the design must conform to the outlines of the wearer's body.

• **Biggest problem—heat**—The major design problem, the study said, will be the extreme variations in temperature.

For instance: Temperatures will be very hot if the man is between the sun and the vehicle. Here he will be receiving the direct radiation of the sun, reflection and emission from the vehicle, and earth albedo and earth emission.

On the other hand, he might be in the shadow of both the earth and the vehicle—an extremely cold situation.

Furthermore, the same suit will be worn in the controlled temperatures and humidity of the cabin during emergency periods of the journey, such as launch and re-entry.

In the hottest case, researchers have determined that 1300 Btu/hour must be removed from inside the suit. Under the best or coolest condition, 350 Btu/hour must still be removed.

A complementary heat balance system must be designed, as well as air circulation for breathing and humidity control. As project head Norm Belasco points out, an attempt to cool the spaceman with air flow would surround him by a miniature cyclone.

• **Radiation**—The Air Force chose the 500-mile limit because critical quantities of radiation seem to begin at about 540 miles.

For solar flares, warning devices and emergency procedure (perhaps abort) and equipment are suggested.

A helmet and ear cups must be properly designed for the noise of launch and re-entry. The boundary line of permissible noise is about 130 decibels at 40 cycles per second.

• **Oxygen supply** — Although the study suggests a back-pack approach to life-support systems outside the vehicle, it also mentions a new possibility.

The authors say that it may be feasible to incorporate layers of vacuum-regenerative adsorbers into the suit structure. A thin layer of one of these chemicals would remove CO_2 and water vapor with virtually no design compromises.

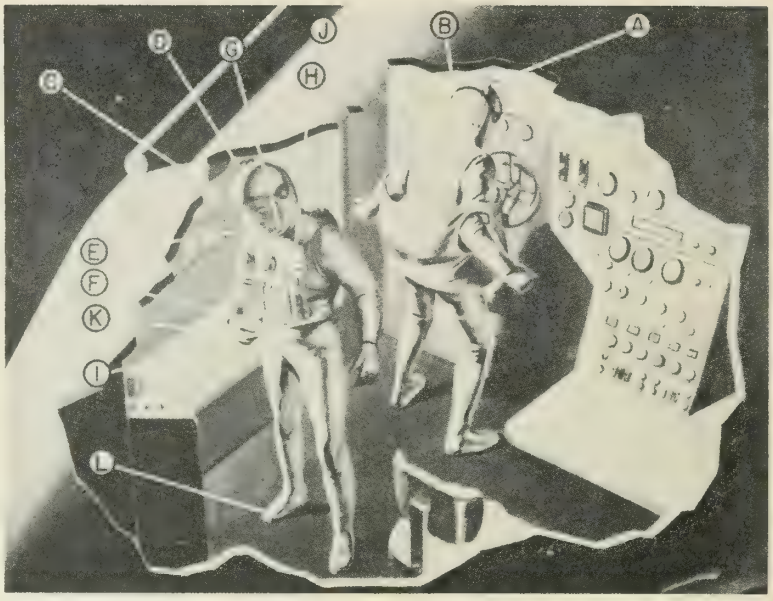
When the suit is removed upon return to the ship, it could be placed in an air lock and exposed to the space vacuum. Within a short time, the CO_2 and water vapor would be released and the suit ready to go again.

• **Donning method** — The easiest way to get in and out of a suit is to use a main closure which "traces" the spine. It is possible to design this closure to have positive interlocking and pressure sealing features, yet be very strong. The classified report on this study gives details.

A better shoulder joint than those in existing suits may be needed. Details on a new design for hip joints are also included in the classified report available at the Aeronautical Systems Division, AFSC, Wright-Patterson AFB.

• **Helmet**—A helmet with a soft back will be easier to put on and remove than the present hard-shell type. The author's concept also includes protective visors, feeding and vomitus removal and buffeting protection.

A novel technique can be adopted for a communications system. The group evolved a transceiver working on such passive elements such as resistors and diodes. This eliminated power-requiring elements such as tubes and transistors. Thus the system wouldn't require a portable power supply, but would operate on power "beamed" from the parent vehicle. ⁂



ASTRONAUTS PREPARE to leave space vehicle to make repairs on the outside in Project SPACE CAPE-type suits. Back closure can be remote-controlled. Legend: A. antenna; B. hard helmet; C. orifice for visor defog spray; D. outer protective visor stack; E. helmet visor; F. remote control activator for pressure sealing, dorsal closure; G. feeding port; H. life support vest with back pack; I. exhaust port; J. pressure sealing main closure; K. thermally protected gloves; L. soft boots.

Europe Antes Up for Space Research

by Bernard Poirier

COOPERATIVE Research in space by European nations is beginning to hit their financial soil.

Before August, major participating countries are expected to have approved budgets totaling about $150 million for international space projects. In addition, almost $50 million annually is earmarked for national programs.

France clearly dominates space planning on the European scene, although Italy has recently adopted an ambitious satellite launching plan.

Three principal groups are striving to unite sufficient European resources in space:

COPERS—the European Preparatory Commission for Space Research made possible through the Meyrin Agreement signed by 11 countries. COPERS was guaranteed financial responsibility on Feb. 27, 1961, and ratified formally on March 13, 1961. Headquarters are in Paris, but COPERS has a short lifetime and is expected to evolve into ESRO.

ESRO—the European Space Research Organization which is expected to start functioning in October, 1962, will establish research centers and manufacture satellites, but will not make rockets. Current plans call for buying U.S. vehicles or the space rocket proposed by ESLO.

ESLO — the European Satellite Launching Organization (*Blue Streak* group) is still in the talking stage. ESLO proposes to produce jointly a 90-ft., three-stage, satellite-carrying rocket using a *Blue Streak* first stage, a French second stage and a West German third stage. Other participating countries, if any, presumably would act as subcontractors to the three national primes in interstage design and manufacturing and in ground control equipment.

Remaining in the background, however, is the only technical proposal yet to be brought forward publicly—that by Britain's Hawker Siddeley Group and France's IRBM agency, SEREB. Their proposal, which might cost as much as $800 million over a four-year period, would culminate in the launching of several experimental communications satellites.

The British group controls seven aviation and missile companies, the largest single aerospace group in the Commonwealth. SEREB (Société pour l'Etude et la Réalisation d'Engins Ballistiques) has shares held by Nord, Sud, SNECMA, ONERA, G. A. M. Dassault, MATRA and SEPR.

The Anglo-French proposal evaluated Western European aerospace potential and outlined several peaceful and military programs believed to be attainable in a four- or five-year time interval.

Along with civil communications satellites, Hawker Siddeley and SEREB proposed *Transit* navigation satellites, propulsion, materials, lightweight structural research and electronic miniaturization development.

• **Streamlined agency**—France recently established a National Center for Space Research—CNES—replacing its French Research Committee, which was cross-fertilized by representation of a number of leading French institutions. CNES is a streamlined Space-Age organization whose charter apparently gives it an individual budget, financial autonomy and freedom of action by reporting directly through a member who operates as the Prime Minister's personal representative.

CNES was recently allotted $16 million as a start, half of which is for international space programs and the other half for France's national space efforts. Already, $25 million is available for space activities in the Program Law adopted in the waning days of 1960. France may commit as much as $120 million during each of the next five years since she is an active COPERS, ESRO and ESLO participant. Her share in ESRO, for example, will be about 20%.

Nationally, France might assign a top priority to orbiting a 110-lb. satellite before the end of 1964. It has already been suggested that the IRBM now in R&D be modified for first-stage work in an all-French-manufactured space rocket. However, there has been some effort to encourage an independent civil/industrial first-stage effort concurrently with the IRBM work.

The French are also considering construction of sites for flight-testing and satellite-launching in metropolitan France—thus cutting logistics and supply costs involved in Hammaguir testing by at least an order of magnitude. Sites at Biscarosse, Levant Island and Quiberon have already been mentioned as replacements of the Colomb-Béchar complex.

Italy is promoting the idea of using Perdasdefuego on Sardinia for a European launching site when ESRO and ESLO are finally ratified. France is offering its current Sahara site or metropolitan sites for consideration, and Australia is interested in European plans coupled to possible use of its Woomera missile testing range.

• **New momentum**—The European space outlook is getting brighter. Although COPERS meetings have been quietly held in Paris and eleswhere in Europe (such as at the Max-Planck Institute in Munich), at least five countries seem to actively support a Laboratory of Space Technology under eventual ESRO auspices.

United here are Britain, France, Switzerland, Netherlands and Belgium. France has offered Brétigny as the site where 900 scientists and technicians would be employed. Other programs suggested for ESRO by the COPERS membership are an Electronic Computing Laboratory for data processing (Germany), an Advanced Research Laboratory for Propulsion (Italy) and instrumentation and materials studies.

Sweden has suggested a launching site at Kiruna, Sweden, which is particularly ideal for solving some of the radio transmission riddles evident during aurora borealis disturbances.

The *Blue Streak* ESLO group has had trouble getting signatures for agreement since the first heralded Strasbourg Conference, but indications are growing that Britain, France and West Germany will go it alone if others do not show a willingness to participate soon.

Rolls-Royce has upped the *Blue Streak* static thrust design from 137,000 lbs. to 150,000 lbs., in anticipation of final European agreement to get going with a serious space effort by utilizing the best available means. Both France and West Germany have finally taken the bit in their teeth; West Germany recently established an Institute of Space Research in its Test Establishment for Aeronautics and Spaceflight.

COPERS membership lists Belgium, Denmark, France, Italy, Netherlands,

(Continued on page 53)

MOBILIZING FOR THE MOON

About fifty-billion dollars will be spent in the next decade to develop the moon program—80% with industry.

NOVEMBER 27, 1961 — MISSILES AND ROCKETS published its NASA Issue, an in-depth study of the National Aeronautics and Space Administration's programs, projects, facilities, personnel, and contracting procedures—emphasis centered on NASA's future material and contract requirements. JANUARY 5, 1962 — Over 1,000 single copies ordered by companies and individuals. JANUARY 11, 1962 —NASA purchased 60,000 reprints of the editorial section of the NASA issue.

NOW — MISSILES AND ROCKETS, for the first time, offers companies interested in doing business with NASA the opportunity to buy reprints of the editorial section of the NASA Issue—1961's most important and informative missile/space publication.

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ASTROLOG

Current status of U. S. missile and space programs plus all orbiting satellites

Missiles

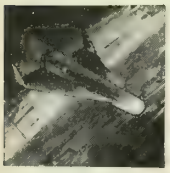
PROJECT	CONTRACTORS	DESCRIPTION	STATUS
ALFA (Navy)	Navy, prime; Avco, air frame	ASW surface-to-underwater; 500 lb. solid; conventional	Deployed on destroyer escorts
★**ASROC** (Navy)	Minneapolis-Honeywell, prime; Sangamo Electric, sonar; torpedo, GE; depth charge, M-H; Librascope-General Precision, fire control	Surface-to-underwater; rocket-thrown anti-submarine missile; nuclear or conventional, range about 8 miles; advanced ASROC (improved Mark 44 torpedo) under R&D	Operational on destroyers, destroyer escorts, heavy cruisers and guided missile frigates.
★**ASTOR** (Navy)	Westinghouse, prime	Mark 45 ASW underwater to underwater wire-guided torpedo; nuclear	Approved for service use and production initiated
★**ATLAS** (Air Force)	GD/Astronautics, prime; GE/Burroughs, Arma, guidance; Rocketdyne, propulsion; GE/Avco, re-entry vehicle; Acoustica, propellant utilization	ICBM; more than 5500-to-9000 mile range; liquid; nuclear; ATLAS "E" series has inertial guidance; earlier ATLAS "D" has radio inertial; proposed ATLAS "G" would have 900,000-lb. thrust and 4000-lb. payload capability	112 launchings; 82 successes, 23 partial, 13 failures; 11 bases for 13 squadrons; operational at Vandenberg, Warren, Offutt, Fairchild and Forbes; total of 54 launchers operational, ATLAS F being tested
★**BOMARC-A** (Air Force)	Boeing, prime; IBM/Westinghouse, guidance; Aerojet/Marquardt, propulsion	Ramjet surface-to-air interceptor; liquid booster; 250 m. range; Mach 2.7; nuclear	Five bases operational in Northeastern U.S. from Virginia to Maine, production completed
★**BOMARC-B** (Air Force)	Boeing, prime; Kearfott/Westinghouse, IBM guidance; Thiokol/Marquardt, propulsion	Ramjet, surface-to-air; solid booster; Mach 2.7; more than 400 m. range; nuclear	First base operational May, 1961; two more planned; A-squadrons will be strengthened with advanced B model
★**BULLPUP** (Navy-Air Force)	Martin, prime; Martin, guidance; Thiokol, Naval Propellant Plant, propulsion; Maxson, second-source prime	Air-to-surface; 3-6 mile range; radio-guided conventional 250-1000-lb. bomb; BULLPUP B: nuclear warhead and I pre-packaged liquid motor; nuclear-tipped model nearly operational; AF designation: GAM 83-A (HE warhead), GAM 83-B (nuclear)	Deployed with Atlantic and Pacific Fleets; operational with Air Force units. Marines launching BULLPUP from helicopters.
COBRA (Navy)	No contract announced	Anti-ship radar missile	Early R&D
★**CORPORAL** (Army)	Firestone, prime; Gilfillan, guidance; Ryan, propulsion	Surface-to-surface; 75-mile range; liquid; nuclear; command guidance	Deployed with U.S. & NATO troops in Europe. SERGEANT to replace CORPORAL beginning this year
CROW (Navy)	No contract announced	Air-to-air missile	R&D; has been flight tested
★**DAVY CROCKETT** (Army)	In-house project directed by Rock Island, Ill., arsenal	Surface to surface; solid; bazooka launched; sub-kiloton nuclear warhead; two launchers; vehicle mounted or carried by two men	Operational in Europe; FY '63 budget funds for majority of inventory objective
★**ENTAC** (Army)	Nord Aviation, prime	Antitank; 6600-ft. range; 37 lbs.; HE warhead; wire-guided; man-portable	Operational; Army buying from French in quantity to replace SS-10
★**FABMDS** (Army)	GD/Astronautics, Hughes, Martin, GE, Raytheon, Sylvania—feasibility studies	Mobile antimissile defense system to provide an effective defense of the field army against enemy ballistic missiles	Feasibility studies submitted to ARGMA last year; now being evaluated by special committees of experts
★**FALCON** (Air Force)	Hughes, prime; Hughes, guidance; Thiokol, propulsion	Air-to-air; 5-mile range; Mach 2; solid; conventional; GAR-11 model has nuclear warhead	Operational; buy-out of GAR 3A, 4A and 11 in FY '62; GAR 9 under continued development
★**EAGLET** (Navy)	No contractors announced	Cut-down EAGLE; air-to-air for use on TFX aircraft	Study
GENIE (Air Force)	Douglas, prime; Aerojet-General, propulsion	Air-to-air unguided; 1.5-mile range nuclear	Operational
GIMLET (Navy)	No contract announced	Air-to-surface; unguided; considered highly accurate	R&D
★**HAAW** (Army)	AOMC, prime	No details available; Heavy antitank/assault weapon	Development; funds provided in FY '63 budget

★ **Indicates changes since January, 1962, Astrolog**

PROJECT	CONTRACTORS	DESCRIPTION	STATUS
★**HAWK** (Army)	Raytheon, prime; Raytheon, guidance; Aerojet-General, propulsion	Surface-to-air; 22-mile range; solid; conventional; provides defense against medium and low-flying aircraft and cruise-type missiles; improvements in system to be phased into production and furnished as modification kits to existing equipment	Operational; deployed in Europe, Panama, Okinawa, U.S. (13 battalions); Jan. 29, 1960 successfully intercepted HONEST JOHN, first known missile intercept of another; '63 procurement will essentially complete deployment objective
★**HONEST JOHN** (Army)	Douglas/Emerson Electric, prime; Hercules, propulsion	Surface-to-surface; unguided; 12-mile range; nuclear; 5800 lbs.; ADVANCED HONEST JOHN has increased performance, lighter and smaller; also developed a lighter-weight mobile launcher and an air-transporter launcher	Operational; deployed in Europe; to be replaced by MISSILE B
★**HOUND DOG** (Air Force)	North American, prime; Autonetics, guidance; Pratt and Whitney, propulsion	Air breathing air-to-surface; 500-mile range; Mach 1.7; turbojet; nuclear; B version in production	Operational; to be launched from B-52G intercontinental bombers; stockpile expected to exceed 400
★**JUPITER** (Air Force)	Chrysler, prime; Sperry Farragut, guidance; Rocketdyne, propulsion; Goodyear/CLT, re-entry vehicle	IRBM; liquid; nuclear	Operational in Italy (30 launchers) with Italian AF; being deployed in Turkey; 30 R&D launchings; 23 successes, 5 partials, 2 failures. 2 Italian training launches: 2 successes
★**LACROSSE** (Army)	Martin, prime; Martin, guidance; Thiokol propulsion	Surface-to-surface; highly mobile; 20-mile range; solid; nuclear	Operational; three units deployed in Europe; more being trained; to be replaced by MISSILE B
★**LITTLE JOHN** (Army)	Emerson Electric, prime; Hercules Powder, propulsion	Surface-to-surface; unguided; 10-mile range; solid; nuclear	First 4-launcher battalion operational this winter; supplements medium and heavy artillery in airborne divisions and air-transportable commands
★**M72** (Army)	Hesse-Eastern Div., Flightex Fabrics, prime	Light antitank rocket; carrier tube launcher; 4.5 lbs.; 25 in. long/3 in. diameter	In production; replaces 3.5-in. rocket launcher and rifle grenade; before type classification system known as LAW
★**MACE** (Air Force)	Martin, prime; Goodyear/AC Spark Plug, guidance; Thiokol/Allison, propulsion	Air-breathing surface-to-surface; more than 650-mile range; turbojet & solid-nuclear; B model has more than 1200 mile range; inertial guidance	Being deployed with U.S. troops in West Germany; new all mobile but hard-base version development completed; to be in Okinawa, Korea; replaced MATADOR in U.S. arsenal
MATADOR (Air Force)	Martin, prime; Thiokol/Allison, propulsion	Air-breathing surface-to-surface; 650 mile range	Being turned over to West Germans; also deployed in Far East
★**MAULER** (Army)	GD/Pomona, prime; Hughes, guidance; Lockheed, propulsion; DeHaviland, IR acquisition	Surface-to-air; radar guidance; highly mobile antiaircraft and antimissile missile for field use; on tracked vehicle; 12 missiles per launcher	R&D; NATO may buy
★**MEDIUM-RANGE BALLISTIC MISSILE** (Air Force)	Guidance: AC Spark Plug and GPI competing for contract	Two-stage, solid propellant, stellar-inertial guidance; entire system contained in one mobile vehicle; range: 300-1500 miles	Development; RFPs to go to industry in Feb.; contractor setup finalized by June 30; state-of-art missile to be developed in shortest possible time; to be deployed in Europe and Far East
★**MINUTEMAN** (Air Force)	Boeing, major contractor; Autonetics, guidance; Thiokol, propulsion first stage; Aerojet, propulsion second stage; Hercules, third stage; Avco, re-entry vehicle; AMF-ACF, rail launcher	2nd generation ICBM; solid; fixed; nuclear; 3 stages	Development; initial procurement late this year; scheduled to be operational mid-1962 at Malmstrom AFB; 9 Launchings: 7 successful, 1 partial; 1 failure; tactical rail system tests completed; 3 squadrons at Malmstrom, Mont.; Ellsworth, S. D.; Whiteman, Mo.; Minot, N. D.; 16 squadrons to be procured through FY '63, more in later years; mobile version killed
M-55 (Army)	Norris Thermador, prime	Four-inch diameter, small, short-range poison gas rockets; to be fired from 45-tube launchers	Operational
★**MISSILE B** (Army)	AOMC, prime	A highly-mobile general-purpose missile; range 10-50 miles	Funds available in FY '63 budget for initial development; eventually will replace HONEST JOHN and LACROSSE; division support weapon
★**NIKE-AJAX** (Army)	Western Electric, prime; Western Electric, guidance; Thiokol, propulsion; Douglas, airframe	Surface-to-air; 25-mile range; Mach 2.5; solid & liquid; conventional	Deployed in U.S., Europe & Far East; 19 battalions still operated by National Guard are gradually being phased out
★**NIKE-HERCULES** (Army)	Western Electric, prime; Western Electric guidance; Hercules & Thiokol, propulsion; Douglas, airframe	Surface-to-air; 75-mile range; Mach 3+; nuclear; antiaircraft, tactical missiles; mobile or fixed	Rapidly replacing NIKE-AJAX; well over 80 batteries deployed in U.S.; increasing number to be manned by Army National Guard Units; more than 10 N-H batteries were deployed overseas in 1961; N-H on Formosa
★**NIKE-ZEUS** (Army)	Western Electric, prime; Bell Telephone, guidance; Thiokol/Lockheed, propulsion; Douglas, airframe	Anti-missile; 3-stage; 200-mile range; solid; nuclear	R&D test launchings at White Sands, and Pt. Mugu, 44 R&D launchings; 28 successful, 14 partial, 2 failures, First successful 3-stage launching Nov. 30, 1961; complete system tests at Kwajalein about middle of year; first ZEUS Kwajalein launching Dec. 14
★**PERSHING** (Army)	Martin, prime; Bendix, guidance, Thiokol, propulsion	Surface-to-surface; two-stage solid; approx. 400-mile range; nuclear; transported on FMC XM474 tracked vehicle; proposed PERSHING II would have 1000-mile range	R&D; to replace REDSTONE, 31 R&D launchings: 27 successes (both stages launched, guidance carried as passenger Dec. 12 for first time), 4 failures. Operational this year in Europe; W. Germany buying PERSHINGS

PROJECT	CONTRACTORS	DESCRIPTION	STATUS
★**POLARIS** (Navy)	Lockheed, prime; GE/MIT, guidance and fire control; Aerojet-General, propulsion; Lockheed, re-entry vehicle	Underwater and surface-to-surface; solid; 1200-mile range; A-1 installed aboard first six submarines; nuclear; A-2 (1500 n.m.) aboard submarines 7-19; A-3 (2500 n.m.) aboard 20th and all subsequent subs; possible A-4 4000-5000 mile range missile under study. Total POLARIS submarine program: 41 with six being added during FY '63 and final six during FY '64	105 launchings of test vehicles; 73 successes; 24 partial; 8 failures; 37 also launched from submerged subs—all cleared surface; 27 successful flights, 10 failures. Five subs each with 16 missiles operational. 29 POLARIS II (A2) R&D missiles successfully launched from submerged Ethan Allen Oct. 23; A2 in production
QUAIL (Air Force)	McDonnell, prime; Summers Gyro, guidance; GE, propulsion; Ramo-Wooldridge, ECM equipment	ECM-carrying bomber decoy; about 200 m. range; jet powered	Deployed at SAC bases; carried by B-52; procurement completed FY '61
RAVEN (Navy)	No contract announced	Air-to-surface; about 500-mile range	Study
★**REDEYE** (Army)	GD/Pomona, prime; Philco/Convair, Atlantic Research, propulsion	Surface-to-air; 4-foot, 20-lb. bazooka-type; IR guidance; solid; conventional; container-launcher disposable	Plans for immediate production cancelled because of unsatisfactory tests
REDSTONE (Army)	Chrysler, prime; Sperry Farragut, guidance; Rocketdyne, propulsion	Surface-to-surface; liquid; 200-mile range; nuclear	Deployed with U.S. troops in Europe; to be replaced by PERSHING
★**REGULUS I** (Navy)	Chance Vought, prime and guidance; Aerojet-General, propulsion	Surface-to-surface; turbojet & solid; 500-mile range; nuclear	Deployed aboard U.S. submarines and cruisers; REGULUS II used as target drone; modernization program initiated during FY '61 to retrofit missiles with a new airborne guidance system; retrofit to be completed by end of FY '62
SEMPER (Marines)	No contracts announced	Believed to be an air-launched missile	R&D testing at Pt. Mugu
★**SERGEANT** (Army)	Sperry, prime; Sperry, guidance; Thiokol, propulsion	Surface-to-surface; solid; more than 75-mile range; nuclear; inertial guidance	In production; procurement, except for training missiles, to be completed during FY '63; will replace CORPORAL; deployment in Europe in 1962
★**SHILLELAGH** (Army)	Aeronutronic, prime	Surface-to-surface; lightweight; can be vehicle-mounted for use against field fortifications, armor and close-in support of troops	Development
★**SHRIKE** (Navy)	NOTS-China Lake, prime; Texas Instruments, guidance	Air-to-surface; anti-radar; formerly called ARM	Development; first production buy in FY '63 budget
★**SIDEWINDER** (Navy-Air Force)	GE-Philco, prime; Philco/GE guidance; Naval Powder Plant, propulsion	Air-to-air; IR guidance; more than 2 m. range; conventional; new 1-C models to have switchable IR and radar-guided warheads and a new and improved rocket motor	Deployed with Navy and Air Force; all-weather type under development; delivery of 1-C version to start early in this calendar year
★**SKYBOLT** (Air Force)	Douglas, prime; Nortronics, guidance; Aerojet, propulsion; GE, re-entry vehicle	ALBM; more than 100-mile range; solid; nuclear; to be launched from B-52 and Vulcan bombers	R&D; to be purchased by British; operational 1964; air drops from B-52 and Vulcan bombers successful
★**SLAM** (Air Force)	No contract announced	Surface-to-surface; low-altitude; supersonic; nuclear ramjet; designed to conduct long aerial patrols at speeds up to 2000 mph.	Propulsion system being developed under project PLUTO; feasibility proven
★**SPARROW III** (Navy)	Raytheon, prime; Raytheon, guidance; Aerojet-General, Thiokol propulsion	Air-to-air; 5-8 mile range; Mach 2.5-3; solid and pre-packaged liquid; conventional	Operational with carrier aircraft, earlier SPARROW I obsolete; production begun on advanced version (SPARROW III B) to be prime armament for F4H-1 interceptor; F3H-2 Demon also to carry III B—presently equipped with SPARROW III and III A
SUBROC (Navy)	Goodyear, prime: Kearfott, guidance; Thiokol, propulsion; Librascope-General Precision, fire control	Underwater or surface-to-underwater anti-submarine missile; 25-30 mile range; solid; nuclear	Operational aboard nuclear-powered attack sub Thresher
SS-10 (Army)	Nord Aviation, prime; GE, U.S. licensee	Surface-to-surface; primarily antitank; 1600-yards range; 33 lbs. solid; wire guided; conventional	Operational with U.S., French and other NATO and Western units; battle-tested in North Africa; U.S. Army replacing it with the ENTAC
SS-11 (Army)	Nord Aviation, prime; GE., U.S. licensee	Surface-to-surface; also helicopter-to-surface; 3800-yard range; 63 lbs; wire guided; conventional	Operational, to be used with airborne units
★**TALOS** (Navy)	Bendix, prime; Bendix/Sperry, guidance; Naval Propellant Plant, propulsion	Surface-to-air; 65-mile range; solid & ramjet; Mach 2.5; nuclear	Operational aboard cruisers Galveston, Oklahoma City and three heavy crusiers; Long Beach, first nuclear-powered missile cruiser, to be equipped with advanced TALOS
★**TARTAR** (Navy)	GD/Pomona, prime; Raytheon, guidance; Aerojet-General, propulsion	Surface-to-air 10-mile range; Mach 2; 15 feet long & 1 foot in diameter; solid dual-thrust motor; conventional	Technical evaluation completed in '61; installed aboard 6 guided missile destroyers and as backup on heavy cruisers equipped with TALOS; advanced version with greater range and improved performance available in 1962
TERNE (Navy)	Kongsberg Vapenfabrikk, prime; Arma, systems integration	Surface-to-underwater ASW missile; 264 lbs; HE warhead	Navy buying from Norway to equip two destroyer escorts
★**TERRIER** (Navy)	GD/Pomona, prime; Reeves/FTL, Sperry guidance; ABL, propulsion	Surface-to-air; 10-mile range; Mach 2.5; 27 feet long; solid conventional; 2 greatly improved versions placed in production during '61	Operational aboard one attack carrier (Kitty Hawk), one light cruiser (Springfield) and six guided missile frigates; also used by Marines for beachhead operations

PROJECT	CONTRACTORS	DESCRIPTION	STATUS
THOR (Air Force)	Douglas, prime; AC Spark Plug, guidance; Rocketdyne, propulsion; GE re-entry vehicle	Surface-to-surface IRBM; 1500-mile range; liquid; nuclear	Operational; 4 bases (60 launchers) set up in England. 69 military launchings: 48 successes; 11 partial; 10 failures, 65 scientific launchings: 56 successful, 2 partial; 7 failures
★**TITAN** (Air Force)	Martin, prime; Bell/Sperry, TITAN I guidance; AC Spark Plug, TITAN II guidance; Aerojet-General, propulsion; Avco, TITAN I re-entry vehicle; GE, TITAN II re-entry vehicle	Surface-to-surface ICBM; 5000-mile range; liquid; 90 feet long; nuclear; TITAN I burns LOX-Kerosene; TITAN II has storable propellants, inertial guidance, bigger payload, greater range, 115 ft. long TITAN III using two segmented solid motors (120 in. dia.) strapped to sides of TITAN II to be developed as space booster	50 launchings test vehicles: 37 successes; 9 partial; 4 failures. 8 bases for 12 squadrons planned; TITAN I scheduled to be operational mid-1961, slipped to early spring; TITAN II scheduled operational early 1963; TITAN I successfully launched from TITAN II silo; first TITAN II test early 1962
TOMAHAWK (Army)	Martin, prime	Antitank	Study
★**TOW** (Army)	No contractors announced	Tube-launched, optically tracked, wire guided, HE warhead	Follow-on to ENTAC; feasibility studies awarded to Martin, McDonnell and Hughes
★**TYPHON** (Navy)	Bendix, missile; Westinghouse, shipboard control	Medium and long range seagoing anti-aircraft and antimissile missiles with offensive capability against surface ships and shore targets; formerly called SUPER TARTAR and SUPER TALOS; solid booster and ramjet sustainer; conventional; supersonic	Development; successor for TALOS, TARTAR and TERRIER; expense of system may delay deployment
WAGTAIL (Air Force)	Minneapolis-Honeywell, prime	Family of airborne RLM's (rear-launched missiles): air-to-air and air-to-surface	Late R&D
ZUNI (Navy)	Naval Ordnance Test Station, prime; Hunter-Douglas, propulsion	Air-to-air, air-to-surface; solid; unguided; 5-m. range; conventional	Operational

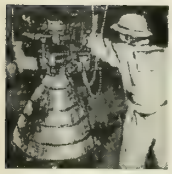


Satellites and Spacecraft

PROJECT	CONTRACTORS	DESCRIPTION	STATUS
★**ADVENT** (Army)	Army Signal Corps, prime; Bendix prime for 24-hour satellite communications package; GE, vehicle	Twenty-four hour instantaneous repeater communications satellite; more than 1250 lbs.; program incorporates Projects STEER, DECREE and COURIER; initial launchings into 5000 mile orbits will use ATLAS AGENA B	R&D; ground sites nearing completion at Ft. Dix, N.J., and Camp Roberts, Calif.; shipboard terminals also being designed; first launchings late '62
★**ANNA** (Army, Navy, AF, NASA)	No contractors announced	Geodetic satellite; 50-100 lbs.; probably spherical; mission: intercontinental surveying using bright flashing light for triangulation	R&D
AEROS (NASA)	No contract announced	24-hour weather satellite earth-stabilized; TV cameras with variable focus; may use SNAP-50 for power	Planning. First flights would be in 1964 or 1965; unfunded FY '62 budget; TV camera R&D to begin soon.
★**APOLLO** (NASA)	North American, Command & Mission Modules, systems integration; MIT, guidance development; tele-communications, Collins Radio; Stabilization & Control, Minneapolis-Honeywell; Environmental control, AiResearch; Parachute Recovery, Radioplane; Escape Tower Rocket, Lockheed Propulsion Co.	Three-man spacecraft for earth orbital, lunar orbital and lunar landing missions. Boosters: Advanced SATURN (C-5) for rendezvous; NOVA for direct flight	Earth orbital shots scheduled 1964-65; lunar orbits 1966; lunar landing, 1967-68. Propulsion and orbiting lab module contracts due before mid-62
★**ARENTS** (ARPA)	GD/Astronautics, prime	Satellites to investigate deep space; 22,000 m. orbits; ATLAS-CENTAUR booster	Contract let to build three payloads; launchings aboard a NASA payload to be re-evaluated due to CENTAUR delay.
★**ASP** (Air Force)	No contracts announced	Aerospace plane, a manned spacecraft capable of operating in the atmosphere and space.	Component development program included in FY '63 budget.
★**BAMBI** (ARPA)	GD/Astronautics, STL	Satellite system capable of intercepting enemy missiles in boost phase using space based platforms and interceptors	Feasibility still unproved; additional research underway
CSAR (Air Force)	No contracts announced	Communications satellite system; satellites to weigh possibly two tons	Studies; possibly operational mid-60's
★**DISCOVERER** (Air Force)	Lockheed, prime; GE, re-entry vehicle	THOR-AGENA and ATLAS-AGENA launchings of early stabilized satellites; main purpose is to test techniques and components for military space systems	Launchings: 38; 11 capsules recovered from orbit (7 air-snatched) after orbiting earth one to three days; testing of AGENA D assigned to DISCOVERER program
★**DYNA-SOAR I** (Air Force)	Boeing, spacecraft and systems integrator; Martin, propulsion; Minneapolis-Honeywell, guidance; RCA, communications data link	Boost-glide orbital spacecraft; program will demonstrate the capability for positive controlled re-entry and recovery from orbit. TITAN III booster	R&D; program reoriented and suborbital flights eliminated, design details finalized during 1961; Project ASSET will test structural integrity, using BLUE SCOUT
★**ECHO** (NASA)	Langley Research Center, prime	ECHO I: 100 ft. inflatable sphere in 1000 mile orbit; passive communication satellite; ECHO II: 135-ft., 700-mi. polar orbit	In orbit since Aug. 12, 1960; ECHO II January 1962, failed to orbit; sub-orbital tests early '62

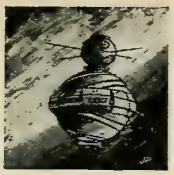
PROJECT	CONTRACTORS	DESCRIPTION	STATUS
★**GEMINI** (NASA)	McDonnell	Bigger and heavier MERCURY capsule; to carry two men for periods up to two weeks	Development; will be used to determine feasibility of rendezvous for lunar mission; also to test men and components for APOLLO; first unmanned flights, 1963; manned and rendezvous flights, 1964
MARINER (NASA)	JPL, prime	450 lbs unmanned spacecraft for early interplanetary missions; boosted by ATLAS-AGENA B	Seven shots planned. First scheduled Venus fly-by Aug. 1962
★**MERCURY** (NASA)	McDonnell, capsule	First U.S. manned satellite; 4000 lbs. + (capsule including escape rocket); boosters: ATLAS and REDSTONE	First manned orbital flight Feb. 20, 1962 by Lt. Col. John Glenn, USMC. 2-orbit chimp shot successful Nov. 29; extended (24 hr) flights planned early next year with modified MERCURY capsule
★**MIDAS** (Air Force)	Lockheed, prime; Aerojet IR detector system	Early-warning satellite; detect ICBM launchings by IR; R&D models weigh 2.5 tons; operational system 12-15 satellites	R&D; second launching May 24, 1960 partial success; no launchings of MIDAS during FY '61; two DISCOVERER satellites launched July 12 and Oct. 21 were used for testing MIDAS IR detection equipment in space
★**NIMBUS** (NASA)	GE, integration and testing	2nd generation weather satellite; earth-stabilized polar orbiting; 650 lbs.; TV cameras and IR scanners in payload; THOR-AGENA B booster	First launching scheduled in FY'63; four R&D satellites presently planned
★**OAO** (NASA)	Grumman, prime; Westinghouse, electronic components; GE, stabilization and control	3500-lb. orbiting astronomical satellite observatory equipped with two large telescopes; boosted by SATURN E-I	First flight scheduled in late 1963 or 1964
OGO (NASA)	Space Technology Laboratories, prime	1000-lb. satellites with instruments for geophysical measurements: polar (POGO) and eccentric (EGO) shots planned; ATLAS-AGENA B, THOR-AGENA B, CENTAUR boosters	First flight scheduled in 1963; 19 experiments planned for first shot
OSO (NASA)	Ball Brothers, prime	440-lb. orbiting solar observatory; THOR-DELTA booster, S-16 early version; S-17 and S-57 advanced versions	First flight planned this spring for S-16; first flight for S-17 planned for 1962
★**PROSPECTOR** (NASA)	No contract announced	Soft-landed, remote control, unmanned moon exploring or manned-lunar support spacecraft; SATURN booster	Early design phases; mission will essentially be determined by requirements of APOLLO program
★**RANGER** (NASA)	JPL, prime; Aeronutronic, capsule; Hercules, retrorocket	300-lb. instrumental capsule rough landed on moon; ATLAS-AGENA B booster	R&D; first two flights RANGERS failed to launch from orbit; RANGER III launched Jan. 26; failed to impact moon, went into solar orbit; nine RANGERS planned
REBOUND (NASA)	No contract announced	System of 3 to 6 multi-launched ECHO II	First orbital flight scheduled for 1963 or 1964
RELAY (NASA)	RCA, prime	100-lb active repeater experimental communications satellites. Commercial system planned; DELTA booster	Britain, France, Brazil and Germany building ground stations; first launching this year
★**SATELLITE INTERCEPTOR** (Air Force)	RCA, prime	Anti-satellite inspection system; to be complemented by interception system; about 2 tons; ATLAS-AGENA B launched	R&D; formerly known as SAINT; during March, 1961, contracts let to design, fabricate and test the spacecraft
SAMOS (Air Force)	Lockheed, prime	Reconnaissance satellite; formerly SENTRY; R&D model weighs 4100 lbs.	R&D; SAMOS II successfully launched Jan. 31 from Vandenberg; scheduled to be operational late 1962; advanced SAMOS under development; SAMOS III launching failed Sept. 9; satellite believed to be SAMOS IV launched Nov. 22
SERT (NASA)	RCA, prime	Spinning satellite carrying two electric-propulsion engines for environmental tests	SERT I to be launched last quarter 1962 with Hughes and Lewis Center engine
SLOMAR (Air Force)	Lockheed and Martin, prime	Logistics, maintenance, supply spacecraft for space systems	Study contracts awarded in Dec., 1960
SURVEYOR (NASA)	Hughes, prime	750-lb. spacecraft soft-landing 100-300 lbs. instruments on moon; ATLAS-CENTAUR booster	First moon flights 1963; seven or more to be launched by 1965
★**SYNCOM** (NASA)	Hughes, prime	24-hr. instantaneous repeater communications satellite. DELTA booster; 16-55. lb. satellite; initial inclination to be 30 degrees	R&D; first launching scheduled late 1962
★**TELSTAR** (AT&T-NASA)	BTL, management for AT&T	125 lb., active repeater, experimental industry communication satellite; DELTA booster. To be launched into 3000 mile orbit	R&D; two to four satellites planned; first launching scheduled in spring by NASA on cost-reimbursed basis
TIROS (NASA-Wea. Bu.)	RCA, prime	Meteorological satellite; TV pictures of cloud cover; TIROS II and III carried IR scanner	R&D; first launching April, 1960; second Nov. 23, 1960; third last July 12, fourth Feb. 8, all successful; four more planned.
★**TRANSIT** (Navy)	Applied Physics Laboratory, prime	Navigational satellite; R&D model weighs more than 250 lbs.; operational model about 50-100 lbs.	TRANSIT IIIB launched into poor orbit Feb. 21; IVA orbited June 29 with 2 piggyback payloads that failed to separate; IVB with TRAAC orbited Nov. 15; 4-satellite operational system scheduled to be in orbit by last quarter 1962

PROJECT	CONTRACTORS	DESCRIPTION	STATUS
★**VOYAGER** (NASA)	No contract announced	Unmanned spacecraft to orbit Mars or Venus; eject several hundred pound TV capsule for planetary entry; SATURN booster weight; approx 2400 lbs.	Study; first flight planned by 1965
YO YO (Navy)	No contract announced	Tactical sea-launched one-pass reconnaissance satelloid	R&D
X-15 (NASA-AF-Navy)	North American, prime; Thiokol, propulsion	Rocket plane; 4000 mph; flight at edge of space; on AF model each XLR-11 rocket engine develops 16,000 lbs. of thrust; XLR-99 engines 50,000 lbs. Three planes delivered.	Powered flights in progress; plane #1 has hit Mach 3 and more than 136,500 ft. with XLR-11 engine; plane #2 with XLR-99 engine turned over to NASA; has hit 4093 mph speed record; altitude record of 217,000 ft. (unofficial for manned, powered flight); plane #3 flights beginning



Space Vehicles

★**ADVANCED SATURN**	S-IB, Boeing; S-II, North American; S-IV B, Douglas; F-1, North American; J-2, Pratt & Whitney	S-1B: 5 F-1 engines; S-II: 5 J-2 engines; S-IVB: J-2 engine; 1st stage: LOX/RP; Upper Stages LOX/H_2;100 ton payload in 345 miles orbit; 43 tons to escape velocity.	R&D; first flight scheduled for 1965; booster planned for APOLLO missions, if rendezvous scheme is successful.
★**AGENA** (Air Force)	Lockheed, prime; Bell, propulsion	1700-pound satellite after burnout; AGENA B stop-start 2450-lb. engine; about fuel capacity AGENA A. AGENA D to be developed as a standardized booster for a variety of payloads	Used in DISCOVERER, SAMOS and MIDAS programs; larger AGENA B also to be used with ATLAS and THOR
BLUE SCOUT (Air Force)	Aeronutronic, prime; Minneapolis-Honeywell, guidance; Aerojet/Hercules, Thiokol propulsion	Solid multi-stage booster based on SCOUT components	Operational
★**CENTAUR** (NASA)	GD/Astronautics, prime; Pratt & Whitney, propulsion; Minneapolis-Honeywell, guidance	Pair of LOX-liquid hydrogen engines; 30,000 lbs. total thrust, atop ATLAS booster, capable orbiting 8500 lbs. launching 1450-lb. space probe.	First flight test slipped to late March or April; first engine delivered
DELTA (NASA)	Douglas, booster; Bell, guidance; Rocketdyne/Aerojet/ABL, propulsion	Successor to THOR-ABLE; upper stage guidance; 500 lb. payload capacity	Interim launch vehicle for TIROS-ECHO; being used for other satellites and one deep space probe; 26 on order
★**NOVA** (NASA)	No prime announced; Rocketdyne, propulsion	1st Stage: 5 F-1 engines; 2nd Stage: 5 J-2 engines; 3rd Stage: 1 J-2 engine; Payloads: 175 tons in 345 mile orbit; 75 tons to escape; 50 tons planetary probe (liquid)	R&D on 1.5 million lb. F-1 engines; vehicle contracts expected to be awarded this year; F-1 test-fired 19 times at more than 1 million lbs. thrust; alternative to advanced SATURN (Rendezvous) and ROVER nuclear rocket
★**NOVA** (Air Force-NASA)	No contractor announced	Clustered 12 million—20-million-lb. booster; possible alternative to NOVA-L (solid)	R&D; prelimary development contracts expected to be let in 1962
ORION (Air Force)	General Atomic	Space booster launched by series of atomic explosions	Advanced engineering studies under way; tests may be attempted with resumption of nuclear testing
PHOENIX (Air Force)	No contracts announced	Recoverable booster—possibly a modified F-1	Studies
★**ROVER** (NASA, AEC)	Aerojet, NERVA prime, Westinghouse, propulsion	First nuclear rocket: KIWI non-flying test engines and NERVA flight engines	First NERVA test flight expected 1966-67
★**SATURN C-1** (NASA)	Marshall Center, S-1 stage, Chrysler Corp.; S-IV, Douglas	2-stage vehicle for early orbital tests of APOLLO and various space programs; 1st stage: LOX/RP; 2nd stage: LOX/H_2; 20,000 lbs into 345 miles earth orbit	First C-1 launching Oct. 27 from Cape, successful; booster with inert upper stages flew 214.7 miles, (84.8 m. apogee); second R&D launching scheduled in April or May; first flight with live upper stages 1963; second stage to be launched in 1963
SCOUT (NASA)	Chance Vought prime; Minneapolis-Honeywell, guidance; Aerojet-General/Hercules/Thiokol/ABL, propulsion	Solid four-stage satellite launcher; 150 lb. payload in 345 m. orbit	SCOUT flights in '61 completed R&D; Navy proposing SEASCOUT for seaborne surface launch, would be based on POLARIS and SCOUT
★**SPAROAIR** (Navy)	Naval Missile Center, prime	Air launched, 2 stage booster; solid; 12 ft. long; 35 lb. payload; launched from F4D; SPARROW motors used	Ten launches planned; first in successful July '62
THOR-ABLE-STAR (Air Force-NASA)	STL, prime; Rocketdyne/Aerojet-General/ABL, propulsion	Three-stage vehicle, orbital capability 800 lbs. Upper stage has restart engines	THOR-ABLE phased out. Used in TRANSIT and COURIER



Satellites in Orbit

★**EXPLORER I** (30.8 lbs.) U.S. Launched 1/31/58, est. life 7-10 years. Orbits earth; perigee 219 m., apogee 1082 m., period 106.0 min. (Discovered Van Allen Belt); not transmitting.

★**VANGUARD I** (3.25 lbs.) U.S. Launched 3/17/58, est. life 200 1000 years. Orbits earth; perigee 412, apogee 2443, period 133.9; transmitting.

LUNIK I "MECHTA" (3245 lbs.) Russia. Launched 1/2/59. Believed to be in orbit around sun on 15-mo. cycle; not transmitting.

★**VANGUARD II** (20.7 lbs.) U.S. Launched 2/17/59, est. life 100-250 years. Orbits earth but is "wobbling"; perigee 306, apogee 2083, period 125.3; inclination to equator 32.87°; not transmitting.

PIONEER IV (13.4 lbs. U.S. Launched 3/3/59. Orbits sun, and achieved primary mission—earth-moon trajectory; not transmitting.

★**VANGUARD III** (about 100 lbs.) U.S. Launched 9/18/59, est. life 50-150 years. Orbits earth; perigee 320, apogee 2314, period 129.8; not transmitting.

★**EXPLORER VII** (91.5 lbs.) U.S. Launched 10/13/59, est. life 30-40 years. Orbits earth; perigee 344, apogee 669, period 101.1; not transmitting.

PIONEER V (94.8 lbs.) U.S. Launched 3/11/60, est. life forever. Orbits sun, interplanetary environment probe; completed one full orbit 1/16/61; aphelion .9951 au, perihelion .8061 au, not transmitting.

★**TIROS I** (270 lbs.) U.S. Launched 4/1/60, est. life 50-150 years. Orbits earth; picture-taking weather satellite; perigee 432, apogee 464, period 99.1; transmitting.

★**TRANSIT IB** (265 lbs.) U.S. Launched 4/13/60, est. life 6 years. Orbits earth; perigee 221, apogee 408, period 94.7. First R&D navigation satellite. Not transmitting.

★**SPUTNIK IV** (10,008 lbs.) Russia. Launched 5/15/60, est. life 2-3 years. Orbits earth; initial perigee 188, apogee 229—changed to 191/429 on 5/19/60; last reported—perigee 160, apogee 263, period 91.4. Test of support systems, cabin, for manned space flight; attempt to return from orbit failed; payload, case and two pieces now in orbit. Not transmitting.

★**MIDAS II** (5000 lbs.) U.S. Launched 5/24/60, est. life 8-15 years. Orbits earth; perigee 297, apogee 312, period 94.2. Telemetry for IR scanning failed two days after launch. Not transmitting.

TRANSIT II-A (223 lbs.) U.S. Launched 6/22/60, est. life 50-200 years. Orbits earth, perigee 389, apogee 649, period 101.6. Transmitting.

★**NRL SOLAR RADIATION SATELLITE I** (40 lbs.) U.S. Launched 6/22/60 with TRANSIT II-A, est. life 50-200 years. Orbits earth; perigee 382, apogee 655, period 101.6. Not transmitting.

★**ECHO I** (132 lbs.) U.S. Launched 8/12/60, est. life 2-16 years. Orbits earth; perigee 689, apogee 1193, period 116.2. First successful orbiting of passive communication satellite.

★**COURIER IB** (500 lbs.) U.S. Launched 10/40/60, est. life 200-500 years. Orbits earth; perigee 590, apogee 765, period 106.9. First successful launching of delayed active repeater satellite. Transmitting.

EXPLORER VIII (90 lbs.) U.S. Launched 11/3/60 by JUNO II, est. life 20-50 years. Orbits earth, perigee 258, apogee 1410, period 112.4. Provides ionospheric measurements for communications. Not transmitting.

★**TIROS II** (280 lbs.) U.S. Launched 11/23/60, est. life 200-500 years. Orbits earth; perigee 385, apogee 454, period 98.2. Not transmitting.

SAMOS II (4100 lbs.) U.S. Launched 1/31/61. Orbits earth; perigee 295, apogee 339, period 94.9. First R&D reconnaissance satellite.

VENUS PROBE (1419 lbs.) Russia. Launched 2/12/61, aphelion 1.0190 au, perihelion 0.7183 au.

★**EXPLORER IX** (15 lbs.) U.S. Launched 2/16/61. Orbits earth; perigee 466, apogee 1522, period 118.1. A 12 ft. "polka dot" balloon.

★**DISCOVERER XX** (2450 lbs.) U.S. Launched 2/17/61. Orbits earth; perigee 165, apogee 333, period 92.6. No attempt to recover 300-lb. capsule because of malfunction.

★**DISCOVERER XXI** (2100 lbs.) U.S. Launched 2/18/61. Orbits earth; perigee 133, apogee 343, period 92.3. Carried IR equipment for MIDAS program to measure background radiation from earth.

EXPLORER X (78 lbs.) U.S. Launched 3/25/61. Last known position; perigee 110, apogee 112,500, period 50.12. Optical pumping magnetometer. Position uncertain.

★**DISCOVERER XXIII** (2100 lbs.) U.S. Launched 4/8/61. Orbits earth; perigee 164, apogee 254, period 91.3. Capsule ejected in wrong direction, sending it further into space. Not transmitting.

★**EXPLORER XI** (82 lbs.) U.S. Launched 4/27/61. Orbits earth, perigee 303, apogee 1109, period 107.8. Measures gamma rays from the stars absorbed in earth's atmosphere.

★**TRANSIT IVA** (IVA, 175 lbs., GREB III, 55 lbs.; INJUN, 40 lbs.) U.S. Launched 6/29/61. Orbits earth; TRANSIT—perigee 550, apogee 618, period 103.8. GREB-INJUN—perigee 549, apogee 619, period 103.8. Transmitting. GREB III and INJUN failed to separate after three-in-one launch.

TIROS III (285 lbs.) U.S. Launched 7/12/61. Orbits earth; perigee 457, apogee 510, period 100.3. Transmitting cloud cover weather pictures.

★**MIDAS III** (3500 lbs.) U.S. Launched 7/12/61. Orbits earth, perigee 2078, apogee 2203, period 161.5. IR early warning satellite.

★**EXPLORER XII** (83 lbs.) U.S. Launched 8/16/61. Orbits earth, perigee 481, apogee 47,615, period 1586.8. Study Van Allen belts and energetic particles in space.

MIDAS IV (3500 lbs.) U.S. Launched 10/21/61. Orbits earth; approximately 2100 circular; period 172. IR scanning early-warning satellite. Transmitting.

★**DISCOVERER XXXIV** (2100 lbs.) U.S. Launched 11/5/61. Orbits earth; perigee, 155; apogee, 548. Malfunction in orbit forced abandonment of usual attempt to recover capsule.

★**TRANSIT IVB** (200 lbs.) U.S. Launched 11/15/61. Orbits earth; perigee, 592; apogee, 689; period, 105.6. Carried TRAAC piggy back. Satellite is an oeprational prototype of the Navy's navigational satellite. Transmitting.

★**TRAAC** (200 lbs.) U.S. Launched 11/15/61 piggy-back on TRANSIT IVB. Orbits earth; perigee, 592; apogee, 690; period, 105.6. Designed to test new system of stabilization based on the earth's gravitational field. Also designed to supply data on the Van Allen belt. Stabilization test still in doubt.

★**DISCOVERER XXXVI** (2100 lbs.) U.S. Launched 12/12/61. Orbits earth; perigee, 137; apogee, 224; period, 90.4. Capsule ejected from orbit and recovered from the ocean after a record of nearly four days in orbit.

★**RANGER III** (727 lbs.) U.S. Launched 1/26/62. Orbits sun; lunar impact probe; aphelion 1.163 au, perihelion, 0.9839 au. Not transmitting.

★**TIROS IV** (285 lbs.) U.S. Launched 2/8/62. Orbits earth; apogee 521 mi., perigee 442 mi.; period 100.3; weather satellite transmitting cloud cover pictures and IR heat balance data.

★**UNDISCLOSED SATELLITE** (? lbs.) U.S. Launched 2/21/62. AF satellite, probably a DISCOVERER, launched from Vandenburg AFB. No orbital data revealed.

(Orbital data is latest official information as of 1200 Z, February 13, 1962)

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ENGINEERS FOR BASE ACTIVATION

Atlas ICBM operational bases and field test sites are shown in the map on the right. Operational bases are Fairchild AFB, Spokane, Washington; Warren AFB, Cheyenne, Wyoming; Offutt AFB, Omaha, Nebraska; Lincoln AFB, Lincoln, Nebraska; Plattsburgh AFB, Plattsburgh, New York; Schilling AFB, Salina, Kansas; Forbes AFB, Topeka, Kansas; Dyess AFB, Abilene, Texas; Altus AFB, Altus, Oklahoma; Walker AFB, Roswell, New Mexico. Test operations are conducted at Pacific Missile Range, Santa Maria, California; Edwards Rocket Site, Boron, California; Sycamore Canyon, San Diego, California; Atlantic Missile Range, Cape Canaveral, Florida.

Immediate openings exist for assignments at Lincoln, Nebraska; Altus, Oklahoma; Abilene, Texas; Roswell, New Mexico and Plattsburgh, New York.

Base Activation Engineers:
Design or liaison engineers with BS in ME or EE and experience in electrical or mechanical systems required; to be assigned to liaison work at missile launching complexes, or design support work on launch control equipment, propulsion systems, automatic programming and missile checkout equipment operations.

Field Service Engineers:
Engineering degree and field service experience desired; to be assigned as specialists capable of representing the company to the Air Force in technical aspects of the Atlas ICBM.

Electrical/Electronic Engineers:
Graduate engineers with field experience in launch controls, logic control systems, automatic checkout equipment, guidance and flight control, facility electrical power, electronic systems, R. F. systems, telemetering, landlines, or autopilots.

Reliability Field Engineers:
BSEE, AE or ME with strong hardware or design background; to be given assignments with duties which will involve failure investigation and analysis on the Atlas missile and support equipment at field locations. Training will be in San Diego with subsequent assignments at operational bases.

Field Test Engineering:
BSEE, AE, or ME, with field test or design experience in the following:

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Technical Countdown

ASTRONAUTICS

Transit II-A Still Giving Data

After more than a year and a half in orbit, the Navy's *Transit IIA* navigational satellite is still providing valuable data to scientists of the Applied Physics Lab of Johns Hopkins University. Originally launched to study the feasibility of a navigational satellite, *Transit IIA* is now enabling observers to study long-term drag effects on satellites in high orbits. In addition, the satellite has proved the reliability of its still-operational internal components and solar cells.

Does Weather Vary with Sun's Eruptions?

Solar storms, consisting primarily of high-energy protons, may augment the energy normally received in the Earth's atmosphere from the Sun by up to 10% in the auroral latitudes. If it can be established that these energy variations influence the lower atmosphere, says Weather Bureau director Dr. Harry Wexler, meteorologists may have a new key to weather forecasting. The mechanism of such solar disturbances is being studied in a small way with the *Tiros* weather satellite, but to make use of the phenomenon as a forecast tool, Wexler says, there must be sufficient lag between solar cause and atmospheric effect. *Nimbus* and later-generation satellites will be needed to obtain more meaningful data.

OPTICS

New Definition for Thin Film

To cram the largest amount of photographic film possible in the smallest practicable reel, one camera recording Astronaut Glenn's recent orbital flight used a new thin-base film developed by Eastman Kodak. Over 590 ft. of the sensitive hi-speed color film were loaded on a standard 400-ft. spool. Called Ektachrome ER, the 16-mm film has a 0.0025-in. Estar base. ASA exposure index is 160.

C-W Laser Club Grows

Minneapolis-Honeywell is the most recent firm to achieve continuous-wave operation with an optical maser. Only the fourth to accomplish the feat, M-H claims its laser has a very high degree of mechanical stability and is the first to employ interlocking micrometers for precise alignment. Laser action is confined to better than 1.5 seconds of mirror alignment. Stability reportedly exceeds 1 sec./hour without special thermal control or shielding. A helium-neon mixture is used to produce the continuous output beam.

ELECTRONICS

Might be a Guidance Record

General Electric's *Atlas* radio-command guidance crew at Cape Canaveral may be establishing a record for missile launch operations. The recent *Friendship 7* flight was the 122nd launch the group has participated in. Also, Defense Systems Department of GE reports that the command guidance system has been operated for over 8000 hours. Operational reliability claimed is 98%.

Telstar European Program Advances

The British will employ a three-hop microwave link between their Plymouth terminal and Goonhilly Downs, Cornwall, in TV transmission experiments for the Bell Telephone Laboratories' *Telstar* project (M/R, Feb. 26, p. 9). An 85-ft. dish now under construction at Goonhilly will be used to communicate via the *Telstar* communications relay satellite to the U.S. terminal at Andover, Maine. *Telstar* is scheduled for launch about May 22. West Germany will participate in the program with its new-ground station to be built near Reisting, Upper Bavaria.

AF Accepts Minuteman Guidance

After just over a month's acceptance tests at the Air Force's Holloman Test Center, first production models of the *Minuteman* inertial guidance system have been okayed. Built by Autonetics Division of North American Aviation, Inc., the NS-10P entered testing in mid-December.

PROPULSION

Space Committee Hears Hercules

The pie-wedge segmented approach to big solids was presented to House Space Committee members by its inventor, Hercules Powder Co., in a special briefing arranged by Rep. David S. King, a committee member. The process (M/R, Oct. 6, 1961, p. 14) involves stacking these wedges while simultaneously filament-winding the case. Hercules is currently planning a 20-ft.-dia., 120-ft.-high solid booster weighing 3 million lbs. and generating 6 million lbs. of thrust. Preliminary studies have also been made of a 38-ft.-dia. booster capable of handling the initial thrust requirements for the complete *Apollo* mission.

Tape Control Tools in Polaris Program

Lockheed Missiles and Space Co. is using a number of numerically controlled machine tools in the production of *Polaris* missiles. The machines include a turret-type drill, an automatic multiple tool changer and a profiler-type milling machine. These machines were introduced as the *Polaris A-1* reached its operational date.

ADVANCED MATERIALS

Halogen Sensitive Leak Detector Perfected

Designed for use in halogen-contaminated atmospheres, a new leak detector has been developed by GE specialists. The unit can be used to test pressurized enclosures by manually probing seams, joints and welds. The effects of contamination are neutralized through a proportioning valve in the probe.

Titan Silo Doors Tested

The air-tight doors covering the first *Titan* silos at Vandenberg AFB were opened in 15 seconds by the hydraulic mechanisms. The 750-ton unit is 4 ft., 6 in. at its thickest point and tapers to 1-in. thickness on each side of its 60-ft. width. The steel frame weighs over 600 tons, with 150 tons of concrete added at the installation site to complete the unit.

Solids Processing To Be Automated

Materials handling system being adapted by Thiokol expected to cut big booster production costs

by John F. Judge

AN AUTOMATED batch mixing process, said to provide a cheaper and faster production route to multimillion-pound solid boosters, is being installed at the Wasatch Division of Thiokol Chemical Corp.

It will speed production while matching the reliability and quality assurance of current production motors.

The automated batch mixing (ABM) process substitutes electronic controls for operations previously performed manually, thereby providing "input" quality control throughout the manufacturing process as an absolute function.

Thiokol has spent about $350,000 on the first of these processes. The firm has proposed an additional number of ABM systems to the Air Force. This has been accepted, and the construction of these units will start in the near future.

The ABM process also eliminates a significant number of handling operations, leading to greater utilization of existing mixers on a day-to-day basis—a more than 25% increase in capacity.

Electronic metering and reduced materials handling also cut waste. The cost savings from these advantages will, Thiokol spokesmen say, pay for the equipment within three operating years.

Flexibility is inherent to the ABM process. Its "brain" is a control board that permits changing the weights and ratios of input materials to produce several propellant formulations, and to effect minor adjustments between these parameters to compensate for variations between raw materials lots.

The system uses only static switching, giving it both the ruggedness desirable in a portable concept and a long service life.

The process' flexibility indicates an immediate application to the production of very large segmented or monolithic motors where the use of more than one production lot of raw materials is mandatory.

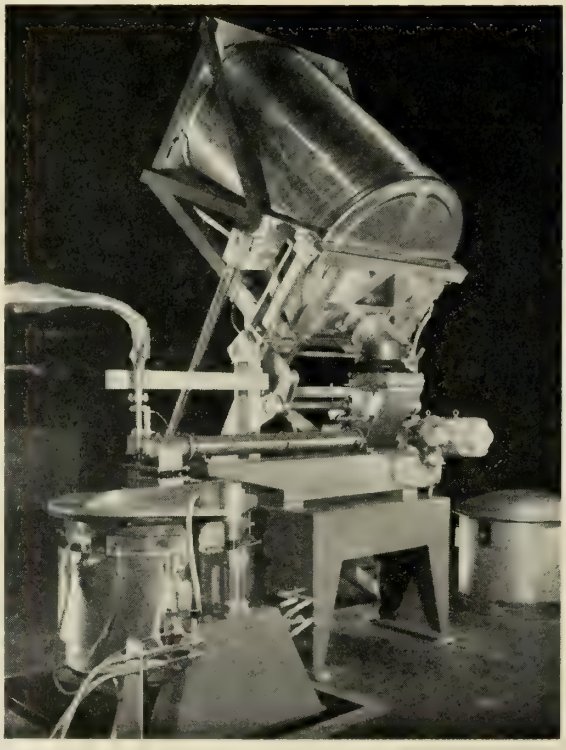
• **Mobility potential** — The current fixed-base process is constructed of proven components—paving the way for a mobile system. This could easily be built, since the components are light and rugged.

The ABM process is essentially an electronically controlled materials handling system. The only development involved in a near-site or marine rocket-loading facility would be the adaptation of mixing equipment to the required environment.

The first ABM system is being built by the Toledo Scale Corp., and will be trucked from Toledo, Ohio, to Thiokol's Wasatch facility in Utah.

The process, although similar in concept to units currently used in the plate glass industry, required extremely close cooperation between Thiokol and Toledo to adapt the equipment to the needs of the solid-propellant industry. Toledo experts needed accurate propellant composition data and processing information to establish the design of feeders and the program boards.

The ingredients of Thiokol's solid propellant are oxidizer, aluminum powder, polymer and a curing agent. This simplicity of composition easily lends itself to the application of automated proportioning and materials handling.



PREMIX ingredient handling facility delivers aluminum from the tilted can and polymer through insulated pipe at left. Heated premix can sits on scale in the foreground. Delivery methods and cut-off valves were developed by Toledo.

The primary considerations that influence the acceptability of a solid propellant formulation are its physical characteristics and its burning rate.

Assuming the acceptability of raw materials, the propellant's physical characteristics are a function of the accurate proportioning of its polymer and curing agent. Burning rate is controlled by the particle size of the oxidizer and the ratio of oxidizer to other propellant ingredients.

The first step in the production of solid propellant is the preparation of the oxidizer—the preparation and blending of various sized particles to obtain the required mixture for the predetermined burning rate. Simultaneously, aluminum powder and polymer must be blended as a premix.

These two ingredients, oxidizer and premix, must then be proportioned to an exact formulation, mixed, and blended with the correct proportioning of curing agent.

The Thiokol/Toledo ABM process deals with the premix and final mix operations. The automated oxidizer preparation system at Thiokol's Wasatch division was also instrumented by Toledo Scale.

• **Diet by the numbers**—The ABM process is essentially a digitalized weight control system that permits the accurate proportioning of ingredients by controlling the input weight of each ingredient to a fraction of a pound within thousand-pound loads. Its control includes a main display panel for the premix installation, another for each mixing facility, and a remote display console monitoring several mix facilities.

In applying the ABM process to a propellant production, a number of procedures were evolved to guarantee absolute control. Many of these also provide positive safety functions.

The system uses sealed cans or "totes" to move blended materials from one station to another. This eliminates any chance for contamination, and thus increases the safety factor.

Each mixing and premix display panel has a locked program board mounted in its front. This board contains both the exact weight information for each ingredient and the allowable tolerance of each ingredient for a specific formulation. Because of the accuracy of the Toledo-developed metering, feed, and readout devices, these tolerances are considerably more narrow than current production tolerances.

The formulation and tolerance limits are programed in the control board by production control personnel. Operators of the control/display consoles cannot tamper with the control board once it is locked into place.

Operators are prevented from overriding the control board by a series of key-actuated locks—somewhat similar to the well-known system in the family car—with all the keys held by supervisory personnel. This interlocking "key control" concept for safety and quality assurance extends throughout the ABM system.

For example, the key that unlocks the mix control board also unlocks the door to the mixer building. Both locks can activate a klaxon horn to warn personnel of deviations in procedure.

Electronic typewriters, connected to each premix control panel and to the monitoring display in the mix facility, add to the quality assurance features of the ABM process. Each typewriter prepares an automatic record of operations performed through the panel.

Typewritten logs accompany each sealed material container from station to station—another cross-check aimed at eliminating human error.

The interaction of the "key lock" control and the typewriter log can be seen by tracing the normal premix cycle.

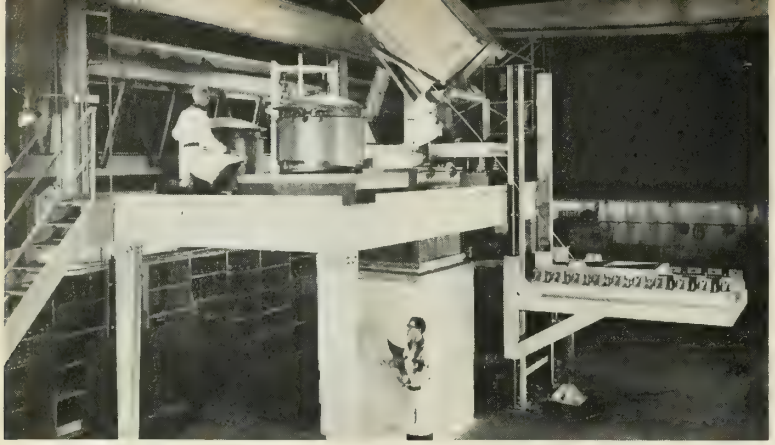
A tote containing approved aluminum powder is positioned above the feed mechanism in the premix facility. A premix can is placed beneath the discharge point of the installation. A hose, water-jacketed to pre-heat incoming polymer, is then attached to this can.

Polymer for the premix installation is pumped from a tank farm—a further reduction in materials handling.

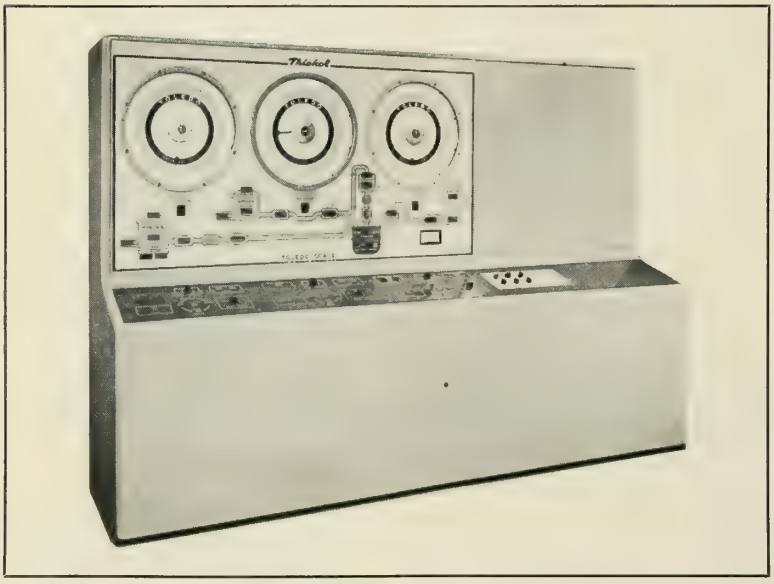
• **Human-engineered displays**—When the display board shows all green (each function on the board is monitored on a go, no-go basis), the operator

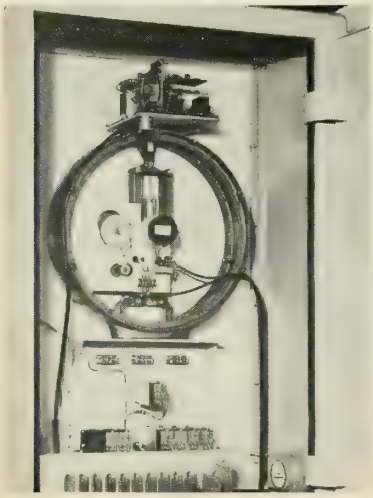
LEFT: *Control board for premix operation shows the three "ignition locks." Large dial scale gives the increase in weight of the premix can as ingredients are delivered. Human-engineered display board has schematic of the premix facility with valves and position indicators in lights.*

ABOVE: *Premix automatic typewriter prints out input information, delivered weights, formulation, date, time, batch number and any corrections. Sheets follow premix can to mix facility. Such printed data gives Thiokol a complete progress report on every batch delivered to a motor.*



LOSS-WEIGHT MIX FACILITY has all three ingredient inputs in position. Oxidizer tote is in tilt position on load cells; premix can (foreground) also rests on load cells. Curing agent handling mechanism is behind premix can. Propellant mixing can is simulated beneath the installation. Load cells are visible on oxidizer elevator. All systems were photographed at Toledo Scale.





ABOVE: *Mix control board is similar to premix board. Programed function is locked in lower center panel. Typewriter logs are stationed at a master console which handles several of these large boards. Key lock functions are also located at the master control console.*

LEFT: *Analog-to-digital scanner is a Toledo Scale development. Unit has been in existence for six years and was adapted to ABM system. This particular unit is mounted on the premix board. Actual conversion takes place close to premix facility itself, to avoid having to transmit analog signals any great distance.*

starts the cycle and immediately, the batch number, formula number, polymer tank number, date, time, and required weight for the initial input are typed on the log. The aluminum powder is then metered into the previously tared premix can.

The premix can is charged while resting on load cells. As these cells indicate that the weight of aluminum is approaching the desired value less a small "minus" tolerance, they activate a signal from the control board to switch the feed mechanism from fast to slow.

Final cut-off of the aluminum feed is accomplished shortly before the actual weight requirement is reached, to account for a small and constant weight of material still falling into the premix can.

At the completion of the feed cycle, the weight of delivered material is automatically checked against programed tolerances. If the delivered weight is within tolerance, entry is made on the typewriter log and the polymer feed cycle is begun. If this weight of material delivered deviates from the programed requirement, the system indicates a failure and refuses to switch to the next cycle.

Since the operator cannot override the program because of the key lock, he must get assistance from the shift supervisor.

The supervisor must then check the delivered weight—shown on the scale dial—against a readout display from the control board—shown below the scale dial—to determine how a fix can be effected. Total error tolerance of the system is pre-set to ±0.2 lb.

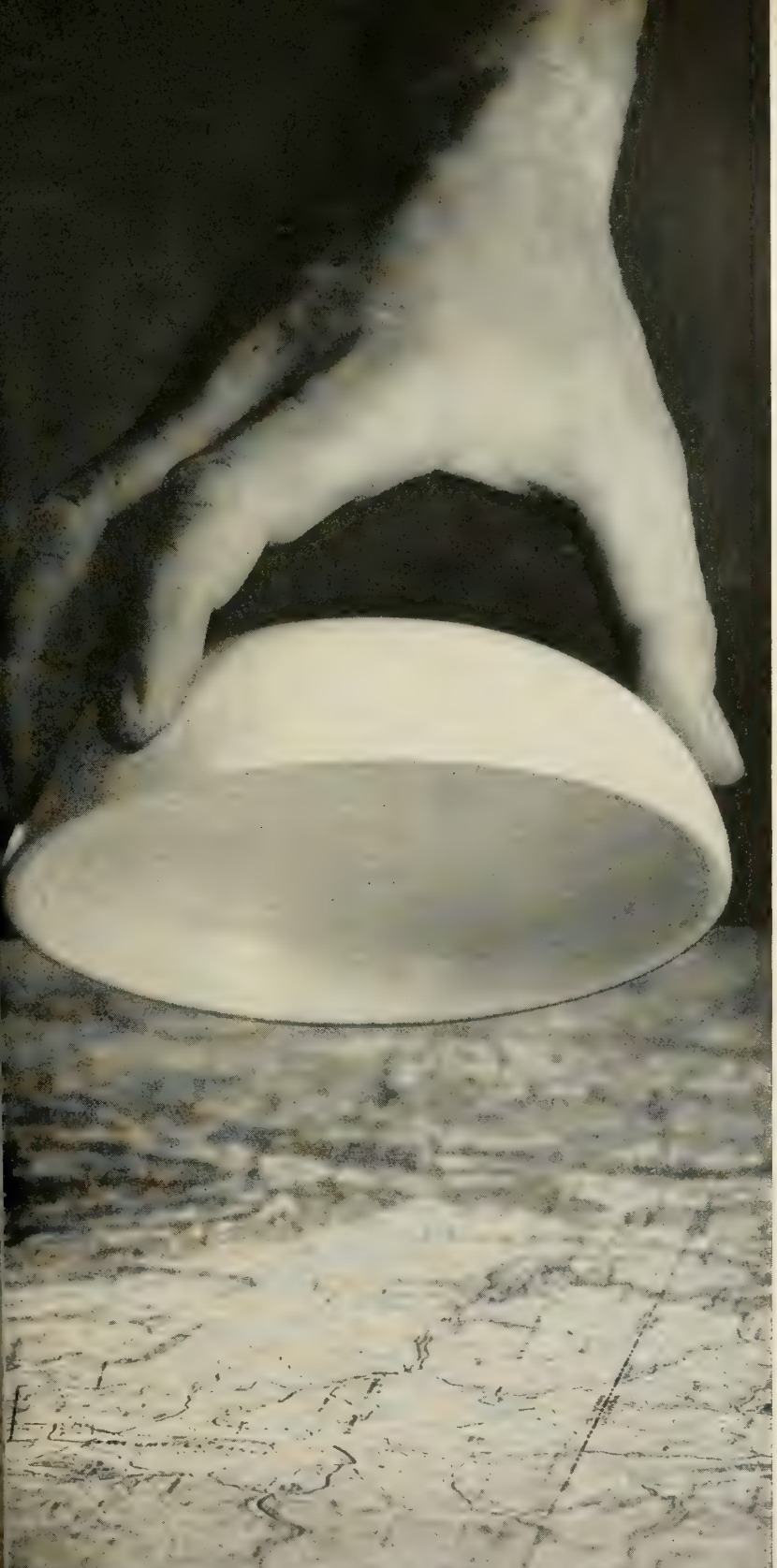
Assuming the delivered weight below tolerance, he first unlocks the system—permitting the actual delivered weight to be entered in "error red" on the typewriter log. He then shifts the control board from automatic to manual, and by pressing a button on the control panel, adds sufficient weight to bring the material delivered within tolerance.

Normally, he will then type this addition onto the control log, sign the log, return the key lock to the "on" position, and permit the premix control to continue in its automated cycle—the addition of polymer.

At the conclusion of the premix cycle, the premix can is pressure-sealed. The typewritten log is then attached to the can, and the can is transferred to the mix facility.

• **"Loss" reads positive**—The operation of the ABM mix installation is similar to that of the premix facility. But the weight measurements here are by "loss-of-weight" from the raw ma-

(Continued on page 46)



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This AMF engineer knows what it takes to shrug off megaton forces. He *had* to know because he designed the prototype atomic bomb shelter at Frenchman Flats, the only building that stood up under the force of the atomic bombs exploded there. Well, not altogether—a flange on the door *was* bent.

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THE 300-PASSENGER Sputnik is claimed able to travel 38 knots in medium to high seas.

ASW engineering

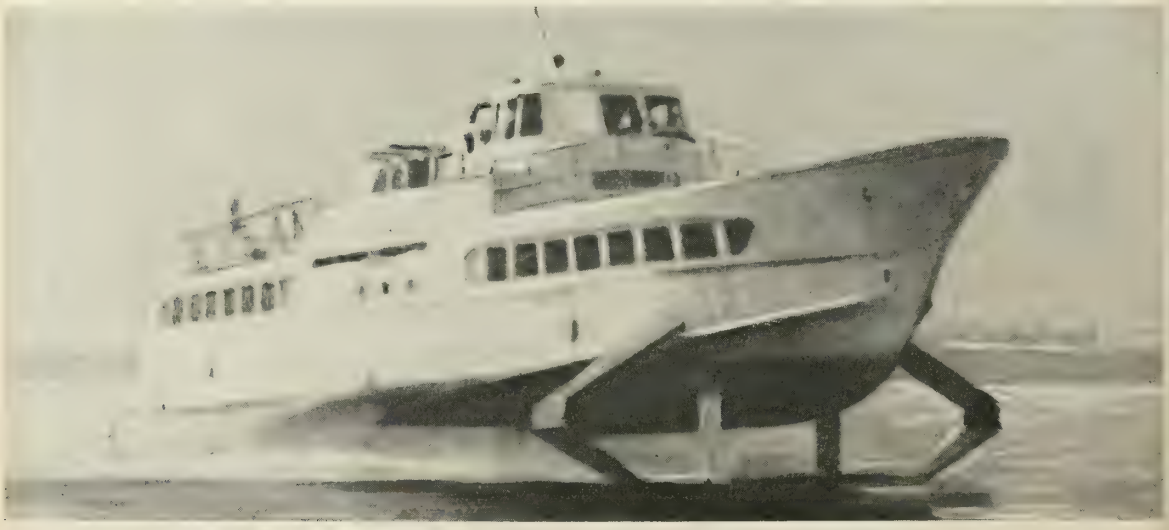
Russia Speeds Up Hydrofoil Production

by William Beller

THE SOVIET UNION is moving at top speed to maintain its lead over the U.S. in commercial hydrofoil craft, raising the question whether Russia is also moving as quickly in developing the craft for use in antisubmarine warfare.

Dmitry Sasorov, correspondent for the Russian press agency Novosti, reports that his country expects to launch next month a 30-passenger hydrofoil craft able to cruise at 55 knots. At the same time, a freight-carrying hydrofoil designed to transport 100 tons of cargo is said to be emerging from the drawing boards.

The U.S. Navy hydrofoil Halobates is also in the 30-passenger weight class but travels only up to 35 knots. Displacing 31,000 pounds and completed in 1957, it is the largest hydrofoil operated up to now by the U.S.



THE 92-PASSENGER Mir was designed to cruise at 40 knots.

THE 150-PASSENGER Meteor is believed to be capable of 40 knots fully loaded.

Developing hydrofoils able to travel at speeds more than 50 knots calls for a technology that is advanced much more than the few knots of extra speed seem to indicate. Reason is that a "cavitation barrier" is reached when hydrofoils start passing 45 to 50 knots, which is difficult to overcome.

Russia's freight-carrying hydrofoil appears comparable to the Navy's 300-ton hydrofoil research ship (AGEH) undergoing final design at Grumman Aircraft Engineering Corp. The Russian craft presumably is to be an operational vehicle, while the AGEH will be used to find out how such a heavy craft behaves on foils.

• **Foils on the Volga**—For nearly five years, Russia has had a family of hydrofoils plying the waters of the Volga, Don, Dnieper, Irtysh, Lena, Yenisei and other rivers and lakes. Some of the craft are to reported to have sailed on the open sea.

Sasorov says that the first Soviet hydrofoil made its maiden passenger cruise on August 25, 1957. Called the "Raketa," the 66-passenger vessel attained speeds up to 40 knots on its trip down the Volga.

Weighing about 28 tons, the Raketa has a hull said to be made of thin steel sheets, with stainless-steel foils under the bow and stern. At rest, the ship's draft is reported to be 6.25 feet; at cruising speed, the draft drops to three feet. The hydrofoils are described as small, not sticking out beyond the lateral line of the hull.

The Raketa was powered by an 800-horsepower diesel, which was later replaced by a "more economical" 1000-horsepower engine, according to Sasorov.

Double the weight of the Raketa, its successor, the 150-passenger Meteor, reportedly was designed for long-range cruises, covering the distance between Moscow and Gorky three times faster than ordinary vessels. (The Meteor is believed to be capable of 40 knots fully loaded.) The Russian correspondent writes that "Her control is automatic and is performed by one person from the wheelhouse."

Unfortunately, from this last statement it is not clear whether the control function is completely automatic. If it it completely automatic, then the Soviet has solved a very difficult engineering problem and one that the U.S. Navy is currently concerned with.

• **A 300-passenger Sputnik**—Last

FIVE-YEAR-OLD Raketa is Russia's first hydrofoil used for passenger service.

LEFT: *U.S. Navy hydrofoil submarine-chaser, the PC(H), scheduled for delivery late this year, will operate in bay and coastal areas and have a cruising speed of more than 40 knots.*

RIGHT: *HS Denison, to be launched sometime this spring, has a top-speed potential of 90 knots. Note the foils about to be fitted on the craft.*

year the Krasnoye Sormovo shipbuilding plant constructed the Sputnik hydrofoil, believed to weigh 107 tons, nearly twice the weight of the Meteor. Sasorov writes that the vessel "carries 300 passengers and weighs 1/50 the weight of an ordinary modern three-decker for the same number of passengers."

The correspondent gives the following data: The vessel is 164 feet long. It is powered by four diesels whose output totals 3600 horsepower. At speed, the vessel has a draft of three feet which means that the Sputnik can sail in shallow waters. "She also performs well on large rivers, developing 70 km/hr (38 knots) in waves 2.5 meters (8.2 ft.) high."

Tests conducted on the Moscow-Astrakham line have shown that the Sputnik is more economical to run than either the Raketa or the Meteor and that the transportation cost is 1/14 that on the best passenger ship in the Volga fleet, according to Sasorov.

The Mir was also turned out by the Sormovo plant last year. Designed to operate in choppy water, this hydrofoil is said to carry 92 passengers and cruise at 40 knots.

(The Mir is strikingly similar to the Supramar PT-20 hydrofoil designed by Von Schertel of Lucerne, Switzerland. The Supramar PT-20 carries 75 passengers at 38 knots, and the vessel makes the Naples-Capri run among several others in Europe.)

By the end of 1961, Georgia shipbuilders had constructed the Kometa, called "the first sea-going hydrofoil craft." During tests, the Sormovo-designed vessel is said to have traveled 3500 statute miles in 70 cruising hours. For three of these hours, "she went at

Navy's Hydrofoil Program

Navy interest in hydrofoils predates World War I but little was done until a rough-water capability appeared possible, which came as a result of technical developments permitting automatic foil-control.

Since 1947, the Navy's Bureau of Ships together with the Office of Naval Research and what was the Bureau of Aeronautics conducted a joint program for hydrofoil research and development. In 1951, the pace of these studies was accelerated and also expanded to include investigations of structures and propulsion systems as well as the hydrodynamic coefficients.

Testing of experimental craft began in 1953. Some of the more significant ones are listed below in roughly chronological order:

Lantern (HC-4). *First Navy hydrofoil test craft. Specifications: length 36 ft., beam 22 ft., displacement 22,200 lb., and speed 18 knots. Operated with fully submerged foils and automatic attitude controls. Developed under direction of Dr. Vannevar Bush by Hydrofoil Corp. of Annapolis, Md.*

XCH-4. *Built about the same time as the Lantern by Dynamic Development Corp., Babylon, N. Y. Specifications: length 54 ft., beam 19 ft., displacement 16,500 lb., and speed 75 knots. Powered by two 450-hp aircraft engines with propellers. Craft had a seaplane-type hull and surface-piercing V-type ladder foils.*

High Pockets *and* **High Tail.** *Two similar 6000-lb. displacement, 24-ft. length vessels built by Baker Manufacturing Co., Evansville, Wisc., the first with surface-piercing V-foils, the second with submerged foils. High Pockets achieved 35 knots but experienced difficulty in following seas. High Tail gave good all-around performance, achieving 30 knots. Indicated greater suitability of submerged foils for Navy.*

Sea Legs. *A modified 29-ft. long Chris Craft cruiser with submerged foils and a highly successful automatic foil-control system. Attained 31 knots. Modified by Gibbs and Cox, New York, N. Y.*

Halobates. *Tested in 1957. Specifications: length 45 ft. 9 in., beam 12 ft., displacement 31,000 lb., and speed 35 knots. Built by the former Miami Shipbuilding Corp., Miami, Fla. The vessel had mechanical feelers and retractable submerged foils. (Vessel said to have proved the feasibility of hydrofoil landing craft.)*

PC(H). *A 110-ft. long submarine chaser for operations at over 40 knots in bay and coastal areas. Two gas turbines, each rated at 3100-hp, power the craft during operations on its submerged foils. Delivery scheduled for late this year. Under construction at J. M. Martinac Co., Tacoma, Wash., under subcontract to Boeing's Aerospace Div., Seattle, Wash.*

Hydrofoil amphibians. *Two experimental 37-ft. long Marine Corps craft to carry cargo shoreward at 40 to 45 knots, proceed through surf after retracting foils; then extend wheels, and drive inland. Testing two different foil systems. One craft is under construction at the Lycoming Div. of the Avco Corp., and the other at Food Machinery and Chemical Corp.'s Ordnance Div.*

High-speed hydrofoil. *A 15-ton, 100-knot catamaran with a Pratt & Whitney turbofan engine (static thrust 18,000 lb.) for foil operations. Length 52 ft., beam*

good speed with only one engine working."

Two versions of this three-cabin hydrofoil are reported to have been built: one carrying 118 passengers for long-distance trips, and a second carrying 150 passengers on suburban routes.

Intelligence from the Soviet indicates that Russian hydrodynamicists have been experimenting with advanced systems such as supercavitating foils and gas-turbine power for their craft.

• **Rough-water operations**—Admitting that the Russians have "a very good solution to their smooth-water problem," a U.S. Navy spokesman maintains that the U.S. is ahead on the sea-going hydrofoils. He explains that this country never had a pressing need for fast water transports. Unlike the Soviet transportation system, the U.S. roads and railroads are capable of carrying any amount of cargo to any destination in the country in a reasonable time. Therefore, hydrofoils were never produced here as a significant commercial venture.

The sea-going hydrofoil tells a different story because of its military value, according to Captain R. T. Miller, Bureau of Ships preliminary design branch head. He pointed out that the PC(H) 110-ft. submarine chaser will be able to operate in the relatively rough waters of the coastal areas. The vessel is scheduled to be delivered this fall or winter. Weighing 110 tons "it will," the captain says, "be bigger than any hydrofoil we know, and will have the most sophisticated control system anybody has yet come up with." ⌘

24 ft. Will test many subcavitating and supercavitating foils and foil arrangements. Contractor, Boeing's Aerospace Div.

Hydrofoil research ship (AGEH). *A 300-ton, 219-ft.-long by 38-ft.-beam research craft. Two gas turbines, each rated at 13,000 horsepower will drive AGEH at about 50 knots; four will drive it at about 80 knots, when the craft is outfitted with supercavitating foils. The AGEH will test a variety of possible applications for the hydrofoil concept. In final design stages at Grumman Aircraft Engineering Corp., Bethpage, N.Y.*

(HS Denison. *A 90-ton open-ocean hydrofoil being developed by Grumman for the Maritime Administration. Powered by an 18,000-hp gas turbine, the craft is expected to achieve about 60 knots with her first set of foils; and possibly 90 knots with a set under development. After a scheduled spring launching and sea trials, the craft to be leased to Grace Lines and put into passenger service between Port Everglades, Fla., and Bahama Islands. Ship will carry approximately 60 passengers.)*

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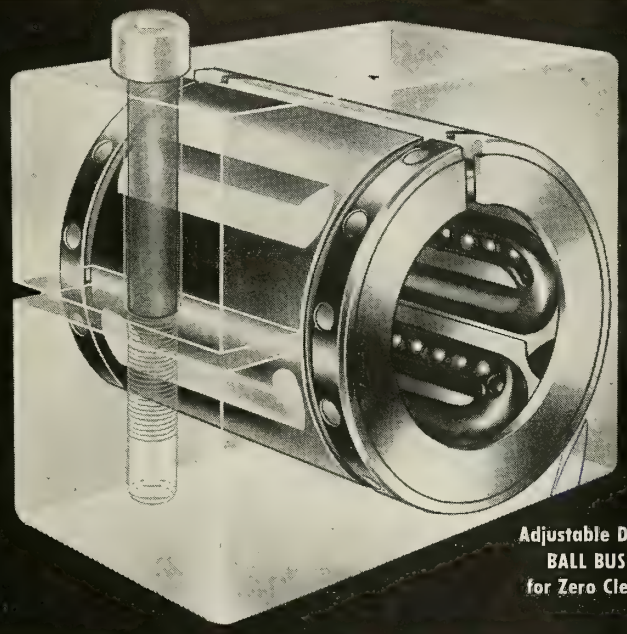

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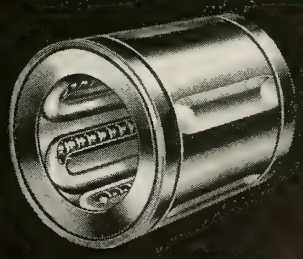

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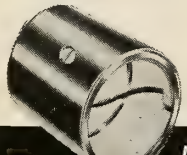

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New Battery May Trim Launch Delays

NEW YORK — Telemetry power aboard advanced versions of *Polaris* will be supplied by a new battery unit capable of delivering either full or limited outputs for periods up to 24 hours after activiation.

The new device could wipe out launch delays due to battery breakdown and replacement during extended or interrupted countdowns.

Reliability tests are under way at Yardney Electric Corp., of New York City, developers of the battery. First production units are also getting trial runs at Lockheed's Space and Missiles Division at Sunnyvale, Calif.

The battery consists of five basic units—four 24-volt sections each with 19 cells, and a 6.5-volt section of 5 cells—and is capable of independent or simultaneous discharge.

According to Yardney officials, the new silver-zinc battery contains several significant design advances not now available in other primary systems.

Most significant is the development of a rapid and automatic activation system which promises high reliability (no moving parts) and long on-the-shelf life (estimated at between five and six years).

An electric charge of 24-30 volts at 5 amps is used to activate a series of gas-generating squibs housed adjacent to the electrolyte tank. The resultant gas moves through a perforated tube leading to the electrolyte tank. Pressure of the gas on the electrolyte is transmitted to a pair of diaphragms in a second tube which leads from the electrolyte tank to the battery monoblock. The transmitted pressure bursts the two diaphragms and allows the electrolyte to flow into the battery. Pressure on the gas ensures equal filling of all 81 battery cells.

• **New manifold design**—A new manifold system was also developed to regulate uniform electrolyte flow and to isolate each cell in order to prevent loss of energy through leakage or "bridging" between cells. Development of this system was essential for maintenance of full power potential throughout the long wet-stand life.

The third area of improved design in the battery, its developers report, is the separator material which impedes the passage of active material between the silver anode, or positive electrode, and the zinc cathode, or negative electrode, but allows certain charged ions to flow through the KOH electrolyte solution.

The Yardney separator, for which patents have been applied, is made in the form of thin and flexible sheets and is basically an organo-metallic cellulosic compound. ⌗

ABM Mix Process

(Continued from page 40)

terial bins rather than as a positive weight gain recorded in the mixer. The operator, because of a conversion at the control panel, reads weight as a positive addition of materials.

The curing agent at the mix facility is contained in a day tank—meaning simply a tank large enough to handle a full day's production run. The curing agent is pressure-fed in incremental batches to a scale. A bin-level indicator determines cut-off of this transfer operation.

Oxidizer arrives at the facility in a tared, scaled sealed bulk container. It is weighed to verify content weight against the accompanying log. The tote is transferred from this scale to a tilting fixture incorporating the feeder assembly. In this second position, it is tared to exclude the weight of the tilt mechanism, feeder assembly, and tote. Only actual content weight is available to the control panel.

Premix loading operations at the mix facility follow the procedure used for the oxidizer.

The load cell outputs at both the premix and mix facilities are in the form of analog signals. These signals are converted to digital pulses in an inert area close to the loading operations. The near-site conversion from analog to digital pulse is another factor leading to the ABM system's extreme accuracy.

• **Extra safety** — Two other safety criteria considered by Toledo and Thiokol when designing the ABM process were ease of maintenance and human engineering. Whenever possible, bolts have been replaced by welds and hidden corners have been rounded to avoid dust accumulation. Button logic and color coding are apparent throughout the system. This reduces operator training time and increases maintenance skills.

Toledo developed two supersensitive scales to check out the premix and mix load-cell subsystems. One scale has a 0 to 4000-lb. range with an accuracy of 1 part in 40,000, or 1 oz. in 4000 lbs. The other scale ranges from 0 to 1000 lbs. with an accuracy of 1/5 oz. Both scales are lever systems built with standard Toledo parts. They utilize deflection readings rather than direct dial through a signal from a linear differential transformer. These scales go with the ABM process to Thiokol.

Before delivery to Wasatch, Toledo will run the ABM system through 50 separate weighings monitored by Thiokol personnel. Each weighing must coincide with the statistical limits established by the specifications.

The ABM process will then be shipped to Wasatch and installed. A second series of 50 weighings will be run and checked against both the first series and the specifications. Thiokol will then accept the process.

The premix segment of the ABM process was conditionally accepted by Thiokol after the first of this series of weighings on Feb. 27.

Total error deviation of the system as tested and accepted by Thiokol is 0.16 lbs. (3σ).

The entire ABM system will give a propellant manufacturer a typewritten log of the complete materials input to the propellant within an accuracy of ounces.

This log is produced automatically by the system; in terms of a large solid booster, the amount of each and every ingredient in each and every batch will have been catalogued by the system before the batch was made.

For the first time, this gives a propellant manufacturer a before-the-fact check on ingredient accuracy. ⌗

The Industry Week

DOD, Industry Push Cost Reduction

Defense contractors were told to cut costs if they want to stay in competition for government contracts. Deputy Assistant Secretary of Defense James Davis said last week that DOD is looking through a very critical eye at the rising cost of equipment procurement. "More and more", he said, "we are emphasizing the incentive contract . . ."

Meanwhile, there were these industry developments:

—The Martin Co. initiated a program to increase managerial efficiency, implementing it through appointment of a general manager of programs review and a director of performance analysis. Martin also awarded a citation to ACF for its contributions to the *Titan* cost-reduction program—$90 thousand plus savings on the original contract.

—General Electric formed a Defense Programs Operation within its Electronic and Flight Systems group to provide greater economy in its aerospace and defense business. Headquarters are in Washington, D. C.

Changes in the Front Office

Roger Lewis took over as president and chief executive of General Dynamics Corp. more than a month ahead of schedule. Reports are that the company wanted its new boss on the job immediately because of a number of important pending projects. . . . *Walter V. Tyminski was elected president and a director of Belock Instrument Corp. He is a former deputy director for military satellite systems of the Lockheed Missile and Space Co.* . . .

News of Mergers and Expansions

Chemical Electronics, Inc., was formed as a subsidiary of American Electronic Laboratories, Inc. to design and market chemical handling and process control equipment. . . . *Ling-Temco-Vought, Inc. consolidated its Ling Electronics, Anaheim, Calif., and Calidyne, Winchester, Mass., divisions into Ling Electronics.* . . . American Electronic Laboratories, Inc., formed a Washington, D.C., Division. A large-antenna range is available for evaluating new designs and testing production antennas. . . . *Hoffman Electronics Corp.'s Military Products Div. established new district sales offices in Boston, Los Angeles and San Francisco.* . . . Benson-Lehner Corp., Santa Monica, Calif., formed a Data Services Div. to meet data-processing requirements of government and industry. . . . *American Super-Temperature Wires, Inc., subsidiary of Haveg Industries, Inc., opened a North Hollywood, Calif., plant.* . . . Linde Co., division of Union Carbide, says construction is 75% complete on a 26-tons-a-day liquid hydrogen plant at Ontario, Calif. Production is scheduled for June. . . .

Cahn Instrument Co. completed new quarters in Paramount, Calif. The new plant is five times the size of present facilities. . . . *Douglas Aircraft Co. abandoned part of its plans to expand Santa Monica, Calif., facilities of its Missile and Space Systems Div. New space labs and test facilities planned for Santa Monica will be located outside that area "for technological as well as geographical reasons."* . . . The Air Force released funds for a $500,000 expansion of the Satellite Test Center at Sunnyvale, Calif. A two-story annex will be built adjacent to the present center. . . . *United Aircraft Research Labs has added a new wind tunnel capable of simulating spacecraft flight conditions at speeds of Mach 60 and altitudes of 300,000 ft.* . . .

Corporate Financial Reports

Douglas Aircraft Co. in 1961 had its first profitable year since 1958, with net profit of $5,957,000, compared with a loss of $19,429,000 in 1960. Missile and space contracts accounted for $402,198,000, or 52.97%, of the company's total backlog. . . . *The Boeing Co. had 1961 earnings of $35,661,000, up from $24,462,000 the previous year. Sales were $1.8 billion in '61, $1.55 billion in '60.* . . . North American Aviation's president said sales in FY '62 may reach $1.5 billion. Sales in 1961 of $1.26 billion were the highest in NAA's history. . . . *Perkin-Elmer Corp. had a sales increase of 8% in the first half of its fiscal year over the same period last year. Earnings for the period were $430,931, compared with $435,681 in the same six months last year.* . . . Corning Glass Works reported sales and earnings in 1961 were the highest in the company's history. . . .

International News Briefs

Wyman-Gordon Co. signed a collaborative agreement with private interests in India to build and operate a forge plant in that nation. It will be called Wyman-Gordon India, Ltd. . . . *Laboratory for Electronics bought Elenik Engineering Co., Stockholm, Sweden, a specialist in design, development, and production of electronic systems for industrial material handling.* . . . FlexTech, Canada, Ltd., was formed as a joint venture of Flexible Tubing Corp. and Anthony Foster and Sons, Ltd., Toronto. Products include FlexFlyte, a heavy-duty ducting to remove fumes, etc., from industrial installations. . . .

Company Name Changes

Martin Marietta Corp's Aerospace Division will revert to the name of Martin Co. Organizational status remains the same. . . . *MM Electronic Enclosures, Inc., Hicksville, N.Y., is the new name for MM Enclosures, Inc. The company designs and manufactures transit, modular, instrument and combination cases for housing electronic equipment and instruments.* . . . John Gombos Co., Inc. changed its name to Gombos Microwave Inc. The company produces microwave components and subsystems. . . .

Acquisitions in the Industry

G. C. Dewey Corp., electronics and physics R&D Company, acquired Pitometer Log Corp. of New York, producers of microwave, electronic and electromechanical equipment. . . . *Texas Research and Electronic Corp. acquired Hallmark Instruments Corp., Dallas.* . . . Cetron Electronic Corp., Geneva, Ill., acquired Associated Engineers, Inc., Agawam, Mass.

AIR FORCE

$18,747,668—**Lockheed Aircraft Corp.**, Sunnyvale, Calif., for research and development of a classified program.

$10,431,600—**Space Technology Laboratories, Inc.**, Los Angeles, for systems engineering and technical direction of *Atlas*, *Titan*, and *Minuteman* programs and for activation engineering for ICBM program sites (2 supplemental contracts).

$9,020,000—**Thiokol Chemical Corp.**, Bristol, Pa., for research and development of improved motor and for production of first-stage rocket motors for the *Minuteman* missile (2 contracts).

$8,820,500—**Philco Corp.**, Palo Alto, Calif., for production of a satellite control subsystem.

$8,600,000—**Lockheed Aircraft Corp.**, Sunnyvale, Calif., for production of satellite vehicles and for research and development of satellite systems (2 contracts).

$6,733,000—**Lockheed Aircraft Corp.**, Burbank, Calif., for production of *Agena* space vehicles. Work to be done in Sunnyvale, Calif.

$4,864,000—**American Machine and Foundry Co.**, Greenwich, Conn., for a *Titan* launcher system (supplemental contract).

$4,200,000—**Philco Corp.**, Palo Alto, Calif., for activities in connection with the satellite program (supplemental contract).

$3,378,000—**General Electric Co.**, Philadelphia, for work on development of communications satellite vehicles (supplemental contract).

$3,365,000—**Hercules Powder Co.**, Baccus, Utah, for development of Stage III motors for the *Minuteman* missile (supplementary contract).

$2,248,952—**General Dynamics Corp.**, San Diego, Calif., for installation and checkout of *Atlas E* missiles.

$2,221,389—**Avco Corp.**, Wilmington, Mass., for research and development of ICBM re-entry vehicles.

$1,500,000—**Radiation, Inc.**, Melbourne, Fla., for two high-gain wideband telemetry antenna systems for use on the Atlantic and Pacific Missile Ranges.

$1,246,550—**Sylvania Electric Products, Inc.**, Mountain View, Calif., for development, installation and test of an area surveillance unit for *Minuteman* launch facilities at Vandenburg AFB, Calif.

$1,981,000—**Burroughs Corp.**, Radnor, Pa., for training of personnel and other work in connection with the SAGE system.

$1,500,000—**Ford Motor Co.**, Newport Beach, Calif., for design, development, fabrication and testing of subsystems for *Atlas* and *Titan* missiles (supplemental contract).

$1,496,612—**Aerojet-General Corp.**, Sacramento, Calif., for ground support equipment and spares for the *Titan* missile.

$1,447,000—**General Electric Co.**, Syracuse, N.Y., for research and development of airborne guidance equipment in support of space programs.

$1,350,000—**General Dynamics Corp.**, San Diego, Calif., for development and production of technical manuals for *Atlas* missiles.

$1,000,000—**North American Aviation, Inc.**, for production of *Atlas* propulsion systems. Work to be done in Canoga Park, Calif. and Neosho, Mo.

$420,000—**Cubic Corp.**, San Diego, Calif., for MATTS scoring kits for use in *Genie* rockets.

ARMY

$10,700,000—**General Dynamics/Pomona**, Calif., for initial development of the *Mauler* guided missile system.

$9,369,580—**Compudyne Corp., C. W. Regan, Inc.**, and **Acme Missile Construction Co.**, all of Hatboro, Pa., to build an aerospace simulator at the Arnold Engineering Development Center, Tullahoma, Tenn. (joint contract).

$1,125,000—**General Dynamics/Pomona**, Calif., for research and development of *Redeye* system.

$410,899—**Western Electric Co., Inc.**, New York City, for procurement of replenishment spare parts for *Nike* missile (4 contracts).

$366,377—**Sperry Rand Corp., Sperry Utah Co.**, Salt Lake City, for *Sergeant* missile ground handling and test equipment.

$207,395—**Douglas Aircraft Co.**, Santa Monica, Calif., for launching items for *Nike/Hercules*.

INDUSTRY

$5,000,000—**Lockheed Propulsion Co.**, Redlands, Calif., from *Space and Information Systems Div. of North American Aviation*, for design and building a solid-propellant launch escape motor for the *Apollo* spacecraft.

$360,000—**The Cosmodyne Corp.**, Hawthorne, Calif., from *Blount Brothers* for liquid nitrogen pumps and vaporizer converters for launch complex 37 at Cape Canaveral, Fla.

$250,000—**Brooks and Perkins, Inc.**, Detroit, from *Bendix Mishawaka Division*, for production of cones for the Navy's *Talos* missile.

NASA

$491,900—**J. Hilbert Sapp Co.**, Orlando, Fla., for construction of a spacecraft building at Cape Canaveral to support the *Centaur* and *Agena-B* programs.

NAVY

$8,000,000—**Thiokol Chemical Corp., Reaction Motors Div.**, Bristol, Pa., for liquid-propellant rocket engines for *Bullpup* missiles.

$2,457,367—**Sperry Piedmont Co., Division of Sperry Rand Corp.**, Charlottesville, Va., for modification kits and associated equipment.

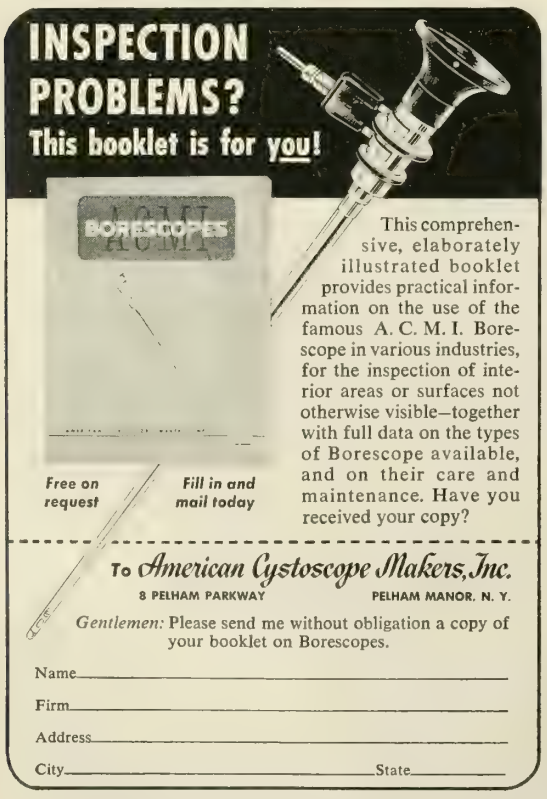
$2,280,000—**General Dynamics/Convair Division**, Pomona, Calif., for services and supplies in connection with equipment associated with the *Terrier/Tartar* missile program, and for supplies and services for maintenance, integrated round production and utilization of the missiles (2 contracts).

$2,143,680—**Aerojet General Corp.**, Sacramento, Calif., for guided missile rocket motor and motor igniter (2 contracts).

$1,940,000—**Chromcraft Corp.**, St. Louis, for rocket launchers.

$1,677,040—**Raytheon Co.**, Lexington, Mass., for high-powered illuminators for the *Hawk* missile system.

$850,000—**Mobile Holdings Corp.**, Cypress, Calif., for mobile home construction for personnel of the *Pacific Missile Range* at Kwajalein Island.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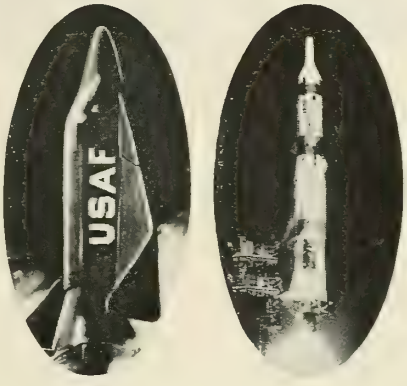


Another first for MISSILES AND ROCKETS, presenting all the nation's military space projects and programs in a single package in

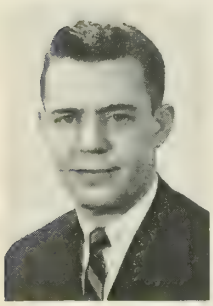
M/R's 2nd annual research and engineering issue—theme: MILITARY SPACE SYSTEMS

The military space budget is expected to more than double in '62 and the upward trend will continue. In M/R's highly successful NASA issue, published November 27, 1961, M/R's editors totally covered NASA's programs and projects. On March 26, 1962, M/R will publish its second annual Research and Engineering issue, the companion to the NASA issue. In it, M/R's editors will cover the military space budget, programs and projects, personnel, facilities, and contracting procedures—with emphasis on what the military will buy in the future. And most important . . . M/R will provide an *Industry Guide to the Military Space Centers.*

Plan for the future by advertising in Missiles and Rockets' Second Annual Research and Engineering Issue—theme: MILITARY SPACE SYSTEMS

ISSUE: MARCH 26, 1962 **MARCH 12, FINAL CLOSING**

names in the news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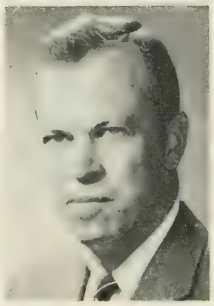
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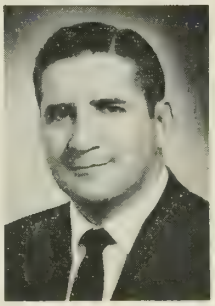
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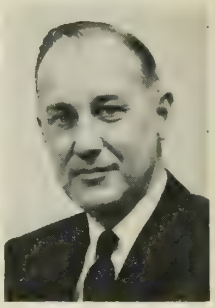
JAHODA


GUEST

Wilbur A. Dunkel: Vice president and lending officer of the National State Bank of Newark, N.J., elected a member of the board of directors of Bundy Electronics Corp.

Edwin C. Johnson: Former U.S. Senator and Governor of Colorado, named chairman of the board of Goorman Electric Corp., Englewood, Colo.

N. Elliott Felt, Jr. and **William G. Martin:** Promoted to position of general manager of programs review and director of performance analysis, respectively, to implement a new Martin Company program putting increased emphasis on overall maangerial performance and efficiency.

Dr. Allen E. Puckett: Hughes Aircraft Company vice president, appointed by the Department of Defense to the Defense Science Board and designated to serve on the advisory group's executive committee.

Dr. Siegfried F. Neustadter: Appointed an engineering specialist at the Applied Research Laboratory of Sylvania Electric Products, Inc., New York, N.Y.

Dr. John W. Abrams: A Defense Research Board astrophysicist, named chief of operational research.

Robert J. Trivison: Brought into Crescent Engineering and Research Company, El Monte, Calif. as vice president.

Harmon Hugo: Elected chairman of the board of Arde-Portland, Inc., Paramus, N.J., and will be replaced as president by **Eliot Brummel.**

Dr. Ernest Ambler. Will direct research studies into the properties of matter at very low temperatures in his new position as chief of the Cryogenic Physics Section of the National Bureau of Standards.

Joseph R. Jahoda: Made vice president in charge of the newly formed Washington Division of American Electronic Laboratories. The division is located in Fairfax, Va.

Byron K. Elliott: President of the John Hancock Mutual Life Insurance Company in Boston, named a director of U.S. Industries, New York, N.Y.

Reed E. Holaday: Promoted to senior scientist from his former position of senior engineer in Litton Industries' Electron Tube Research Laboratory, San Carlos, Calif.

Leon C. Guest, Jr.: Vice President and Controller of General Telephone and Electronics, will become senior vice president-administration of Sylvania Electric Products, Inc., a GT&E subsidiary.

Clyde A. Lilly, Jr.: Will supervise all sales and marketing functions for the Industrial Equipment Division, Eddystone, Pa., of Baldwin-Lima-Hamilton Corp. in his position as manager of marketing. **Herman Frank Hentschel,** coming to the company from General Electric, will fill the post of manager of engineering.

Dr. Orr E. Reynolds: Former head of the Department of Defense's Office of Science, has joined National Aeronautics and Space Administration as director, Bioscience Programs.

Dr. Robert R. Sparacino: Promoted to Director of AC Spark Plug's Research and Development laboratory in Wakefield, Mass., succeeding **Donald J. Atwood,** recently named director of engineering for AC's Milwaukee operations.

Russell Field: Elected a vice president of Southwestern Engineering Co., and named manager of the company's Engineering and Construction Division.

Ralph L. Parr: Previous director of marketing for Dynatronics, Inc., Orlando, Fla., has been made vice-president of marketing for the company.

Dr. Abe Silverstein: Director of the Lewis Research Center, NASA, Cleveland, has been awarded a Career Service Award from the National Civil Service League for his leadership in the *Mercury* program.

Lloyd A. Hatch: Will occupy new position as vice president for long-range planning in Minnesota Mining and Manufacturing Co., being replaced by **Dr. C. W. Walton,** recently named vice president for research.

Ray B. Cox: Appointed vice president and marketing director of the Military Products Division of Hoffman Electronics Corp., Los Angeles.

Reuben M. Siwek: Partner in the law firm of Siwek and Zimmerman, New York City, has been made a member of the board of directors of Designatronics, Inc., Mineola, N.Y.

Harry J. Loynd: President of Parke, Davis and Company, was elected a director of the Bendix Corporation at the annual stockholders' meeting.

John D. Bitner: Promoted to director of logistic support in the Space Systems division of Martin Co.

August Toth: Brought into The Young Machinery Company, Muncy, Pa., as assistant to the president for development of special cost reduction and profit control programs.

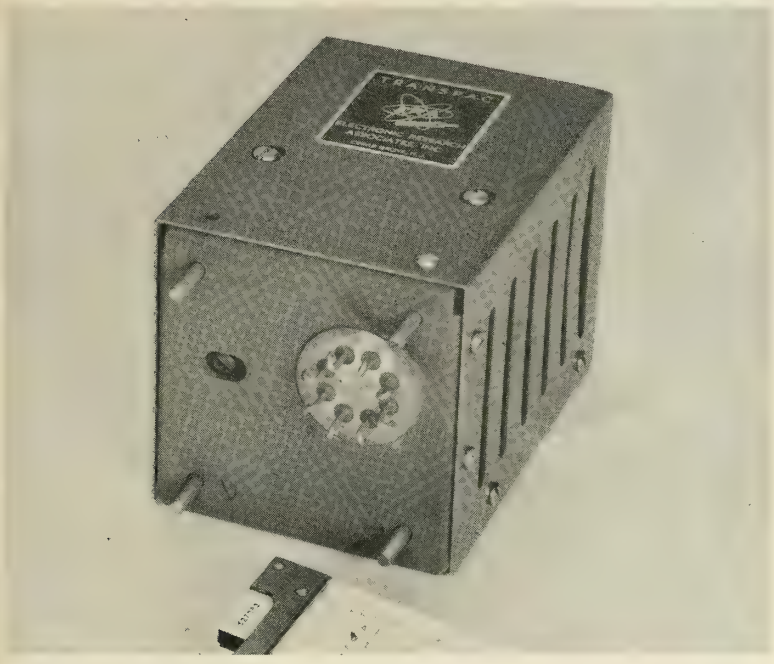
Emanuel Weintraub: Promoted to the presidency of John E. Fast Co., a subsidiary of The Victoreen Instrument Co., New York City.

T. F. Nagey: Director of research at the Allison Division of General Motors, appointed to the combustion and propulsion panel of the Advisory Group for Aeronautical Research and Development, the North Atlantic Treaty Organization instrument for the exchange of technical information.

Carr Wilson: Will be responsible for monitoring the product development program in his new position as senior staff engineer of Giannini Controls Corp., Duarte, Calif.

Maurice T. Ireland: Named manager of the Fabrication Control Department of the Western Development Laboratories of Philco, a subsidiary of Ford Motor Co., Palo Alto, Calif.

George J. Pandapas: Relinquishing his duties as president, assumed the chairmanship of the board of directors of Electro Tec Corp., West Caldwell, N.J. **Arthur Asch** succeeds him as president, and **W. P. Maginnis** joins the firm as executive vice president.



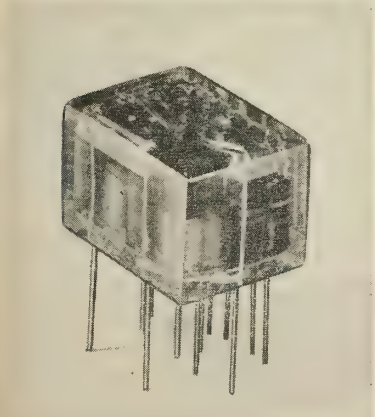
New Product of the Week: Miniaturized Power Packs

ELECTRONIC Research Associates, Inc., is adding a TR-P5R series to their Transpac line of solid-state miniaturized high current power packs. The units provide highly regulated d-c outputs at all battery voltages and current ratings of 0-500 milliamperes. Features include advanced circuit and thermal designs, silicon rectifiers, non-inductive filtering and conservatively rated transistors and components. All units have a ± 1 volt range of adjustment and output current is 0-500 ma. for operation up to 55°C.

Circle No. 225 on Subscriber Service Card

Logic Modules

Electronic Packaging Co., has available a line of low power logic modules. They require only a 1.5 volt power supply and exhibit extremely high fan-out characteristics up to one megacycle operation. Welded, epoxy encapsulated components suitable for wide applications in logic circuit design, each module weighs less than 12 grams and occupies less than 0.5 cubic inch of space. Terminals are 20 mil tinned dumet with 10 mil spacing. There are six circuit configurations available from stock including flip-flop, shift register, clock, half-adder, indicator and nor circuits.



Circle No. 226 on Subscriber Service Card

Transistor Oscillator

The Solid State Electronics Co., has available a transistorized reference frequency oscillator. A completely solid state silicon transistor crystal and heater controlled sine wave oscillator, the unit is solidly encapsulated in lockfoam to minimize weight, resist shock and vibration and to maintain a high degree of insulation to temperature transients. A hermetically sealed snap action thermostat provides positive temperature control under stringent types of environments. Special crystals are utilized capable of withstanding high vibration up to 20 G's from 50 to 2000 cps.

Circle No. 227 on Subscriber Service Card

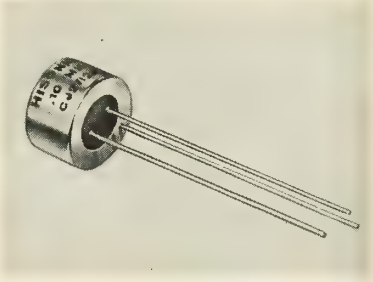
Digital Voltmeter

A high-speed, all electronic, all solid-state digital voltmeter is being produced by Cohu Electronics, Inc., Kin Tel Division. It has a four-digit, projection-type readout, measures voltages with an accuracy of 0.05% on any range. Both range and polarity can be selected automatically. Standard ranges are 9.999, 99.99 and 999.9 volts maximum. It changes range within 0.005 seconds, changes polarity within 0.0001 second, and was designed specifically for data logging systems.

Circle No. 228 on Subscriber Service Card

Grid PC Toroids

Hisonic, Inc., has developed a series of miniature metal-cased toroidal inductors incorporating standard 0.1 inch



grid printed circuit board mounting. The units feature mounting via three 0.030 inch tinned wires at three corners of a 0.20 inch square allowing quick adaptability to the 0.1 inch multiple grid spacing standard for printed circuit board layout. The third wire provides connection to the case. The series features small size and low weight for units of comparatively high Q in the audio and low radio frequency range.

Circle No. 229 on Subscriber Service Card

Electrostatic Tape

An electrostatic shielding tape, EE6105, has been developed by Permacel, for use in a non-shorting, electrostatic shielding wrap on toroidal transformers and bobbin-wound coils.

Constructed of electrodeposited strip copper laminated to one-mil mylar with a silicone, pressure-sensitive adhesive on the exposed mylar edges, it is available in ⅜-in. and ½-in. overall widths

AERO DYNAMICIST

CAREER APPOINTMENT

The Applied Physics Laboratory of the Johns Hopkins University publishes the HANDBOOK OF SUPERSONIC AERODYNAMICS under cognizance of the U. S. Navy. APL now wishes to appoint an Aerodynamicist to its technical staff to critically review, edit, and occasionally rewrite manuscripts for this publication. The appointment is permanent.

The position requires a B.S. in aeronautical engineering, aerodynamics, or physics, plus experience in aerodynamics, aeronautical engineering, or propulsion. Technical writing or editing experience in these areas is desirable.

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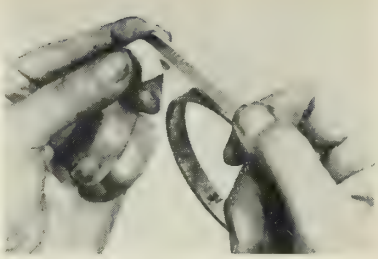

and gives thermal, moisture and electrical stability. Only three mils thick, the tape can be used on small electronic components without sacrificing needed strength. The strength and elongation provide optimum performance features when used as a wrap.

Circle No. 230 on Subscriber Service Card

Synchropot

A line of synchropots has been announced by Daystrom, Inc., Transicoil Division. The synchropot is a standard synchro with a single-turn potentiometer integrally mounted within the back cover. The wiper arm of the pot is on the same shaft as the synchro rotor and may be externally adjusted to calibrate the pot data with the synchro data. They are available with any combination of synchro (control transformer, transmitter, linear potentiometer) used in conjunction with a single-turn potentiometer.

Circle No. 231 on Subscriber Service Card

Delay Equalizers

A series of delay equalizers covering the audio frequency range and exhibiting extremely narrow amplitude variations is available from CircuitDyne Corp., a subsidiary of Telonic Industries, Inc. They are basically L-C networks, providing varying time delays in the audio spectrum from 200 to 3000 cps. Packages in hermetically sealed cases, with standard octal plugs, the equalizers operate over an ambient temperature range of —55°C to 85°C.

Circle No. 232 on Subscriber Service Card

new literature

CIRCUIT BOARD CLEANING—The availability of a single-page, illustrated bulletin describing its printed circuit cleaning equipment has been announced by National Ultrasonic Corp. Bulletin 170 gives complete details, including specifications on a completely integrated automatic ultrasonic system for cleaning and drying printed circuit boards; a semiautomatic model, and a manual system. Included is a discussion on the qualifications that must be met by a circuit board cleaner and testing methods used to determine if or not the board has been properly cleaned.

Circle No. 200 on Subscriber Service Card

MICROWAVE TEST TECHNIQUES —A six-page, two-color application note (No. 54) describing recent improvements in microwave swept frequency test techniques is available from Hewlett-Packard Co. It discusses the methods for using swept frequency techniques to measure swr, coupler directivity, attenuation, signal generator output swr and noise figure; and the plotting of these characteristics with an X-Y recorder. A method is also presented which permits each test device to be swept at a high rate, with the desired characteristics presented on an oscilloscope.

Circle No. 201 on Subscriber Service Card

ASTM-METALLIC COATINGS—This publication, published by the American Society for Testing and Materials, for both producers and consumers of electrodeposited metallic coatings and related finishes contains 29 standards and methods of test, including seven revised items and nine specifications which did not appear in previous editions. It also includes four standards covering the anodizing of aluminum metal and two new laboratory tests specifically designed to determine corrosion resistance of electrodeposited metallic coatings.

Circle No. 202 on Subscriber Service Card

PRECISION RELAY BULLETIN—An illustrated 4-page bulletin containing full performance data on the BR-12 subminiature precision relay series, is announced by Babcock Relays, a division of Babcock Electronics Corp. One model of this series features special "lie down" construction for printed component board applications. Performance specifications emphasize special suitability for applications requiring sensitivity ranging from 25 mw to 250 mw. Standard relays feature 5 ampere contacts rated at 3 amperes to 100,000 operations at 125°C to MIL-R-5757D.

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Circle No. 12 on Subscriber Service Card

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European Cooperation

(Continued from page 21)

Norway, Spain, Sweden, Switzerland, United Kingdom, West Germany and, as an observer, Austria.

At its very first meeting, Belgium, Netherlands, Norway, Sweden and Britain ratified and assumed 38.97% of COPERS budget requirements. On Jan. 27, 1961, France ratified. Switzerland followed suit three days later, bringing the budgetary commitments to 63.74% of the total. However, the "Treaty" could not take effect until a minimum of 70% was pledged. This came about on Feb. 27, when West Germany ratified and her 19.72% brought the committed total to 83.46%.

Executive Secretary Pierre Auger predicted that the final shape of COPERS or ESRO "would be quite similar to CERN (in Geneva) in many respects: status, budget, scope, staff, etc."

Speaking as head of the French Space Research Committee, Professor Auger went on to explain some objectives of France's participation in NASA's International Programs. He said, "The agreement provides for the possibility of conducting experiments dealing with low-frequency radio waves ("whistlers"), night sky luminosity, sodium clouds and aurorae borealis, both natural and artificial."

Auger added, "The instruments to be used will be designed and constructed in France and placed aboard American sounding rockets" and later, "aboard NASA satellites" upon successful completion of the sounding rocket phase.

Returning again to the subject of COPERS, he said legal teams were drawing up the formal agreements for institutionalizing European space research and upon this ratification would the CERN framework become apparent.

• **Success story**—CERN, European Organization for Nuclear Research, was originally sponsored by UNESCO but is now entirely independent. Twelve countries originally signed the 1953 Paris Convention which established the cooperative nuclear research organization; construction of the first laboratories started as early as 1954, with a synchro-cyclotron (600 million electron volts) operating by August, 1957. Larger establishments have since been completed in one of Europe's most successful scientific ventures in international cooperation.

COPERS and ESRO are near the coupling point. The last space hurdle for Europe—ESLO—appears a certainty even with limited membership.

ESLO membership, resulting from the first conference at Strasbourg, has included Australia, Belgium, Denmark, France, Italy, Netherlands, Spain, United Kingdom and West Germany with three observers—Norway, Sweden and Switzerland. ⁂

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What Good is a Baby?

ASTRONAUT JOHN GLENN has done the industry and his country a great service with his remarkable speech before the Joint Meeting of Congress.

The Marine lieutenant colonel never has been known as a man to pass up a good opportunity. Nor did he do so in his Feb. 26 speech to the assembled members of the House and Senate. What might have been taken as the occasion for a few casual and colorful remarks was used by the astronaut for a stirring lecture on this nation's future in the space field.

Those of us in the industry who boldly undertake to advise Congress from time to time on the goals, requirements and potentialities of space exploration sometimes feel that not all the members are paying strict attention.

Congress has shown an intelligent willingness to provide the financing which the Administration has requested for the U.S. space program. In some areas, Congress has led, not followed. Doubters still remain, however.

As influential a member as Sen. Paul Douglas (D-Ill.) raised the question only a few weeks ago of whether any money at all should be spent on the *Apollo* program. He called the lunar landing project "purely a stunt to get there before someone else."

Coupled with the highly successful three-orbit flight and its impact on world opinion, Glenn's speech undoubtedly will have a strong influence on Congressional thinking.

His recounting of the anecdote about Disraeli and Faraday hit directly on target. The British prime minister, visiting the laboratory which was the scene of many of Faraday's early electrical experiments, is said to have asked: "But of what possible use is it?"

Faraday replied: "Mr. Prime Minister, what good is a baby?"

Glenn's explanation of the point of his story was so forceful no editorial writer could hope to improve on it:

"That is the stage of development in our program today," he said, "—in its infancy. And it indicates a much broader potential impact, of course, than even the discovery of electricity did. We are just probing the surface of the greatest advancement in man's knowledge of his surroundings that has ever been made, I feel.

"There are benefits to science across the board. Any major effort such as this results in research by so many different specialties that it is hard to even envision the benefits that will accrue in many fields.

"Knowledge begets knowledge. The more I see, the more impressed I am—not with how much we know but with how tremendous the areas are that are as yet unexplored.

"Exploration, knowledge and achievement are good only insofar as we apply them to our future actions. Progress never stops. We are now on the verge of a new era, I feel."

WE HOPE THE MEMBERS of the Congress and the Administration who cheered and applauded the nation's first orbital astronaut during the dramatic session will long remember and heed his words. He has outlined, succinctly and from the nation's highest platform, the basic philosophy which must guide this country in its approach to space.

The space race with the Soviet Union is important—militarily. We must never let down in that regard or be lured into complacency by Mr. Khrushchev's new sweet talk about space cooperation. We should stand ready to cooperate fully with the Russians in peaceful space endeavors in any way possible—while remembering an old military maxim: you don't arm to meet an enemy's intentions; you arm to meet his capabilities. He can change his intentions overnight; he cannot change his capabilities.

But important though the space race may be, it is not or should not be the basic reason for our ventures into space and we should not let future Russian successes discourage us.

Progress never stops, Glenn said, and our nation must surge to the forefront of that progress or lose its dynamic drive and die.

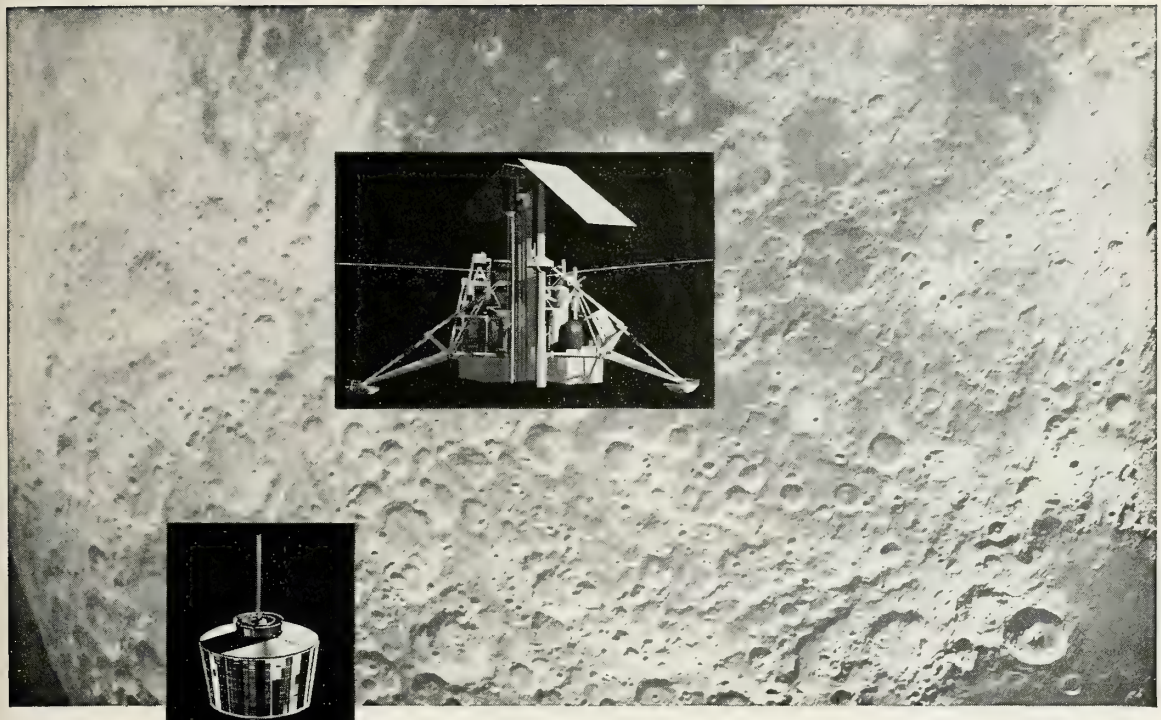
As Glenn pointed out, there is no easy answer to the person demanding to know the immediate payoffs of our effort—the eventual benefits are not even known to man today.

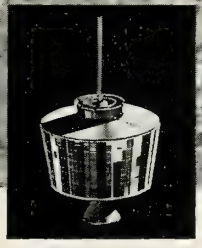
"But exploration and the pursuit of knowledge have always paid dividends in the long run—usually far greater than anything expected at the outset," he said.

The astronaut's words are the Gettysburg Address of our field. Let us hope that fourscore and seven years from now they will be as well remembered.

The baby must be carefully nurtured to full maturity.

William J. Coughlin





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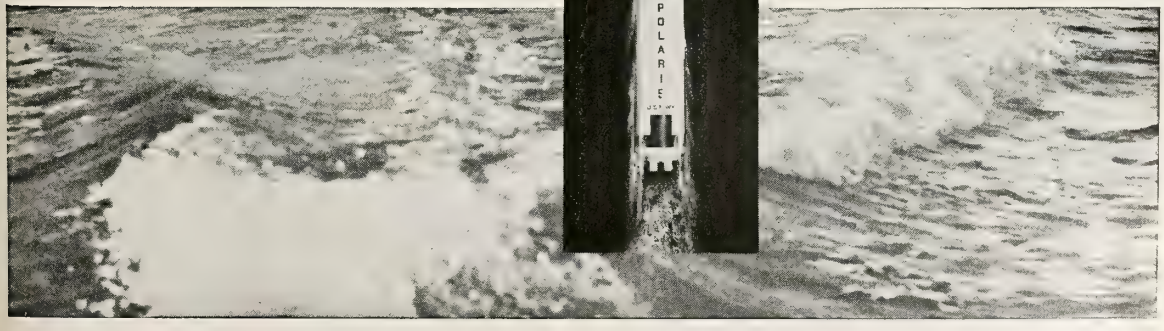

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MARCH 12, 1962

missiles and rockets

THE MISSILE/SPACE WEEKLY

Space-General Astrobee-1500—Follow-on to Aerobee

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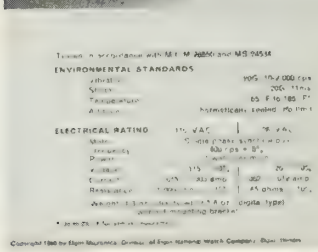
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THE MISSILE / SPACE WEEKLY

missiles and rockets

Volume 10, Number 11 March 12, 1962

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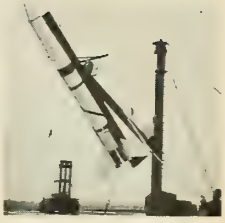
THE COVER



Astrobee-1500 on standard rail launcher at Pacific Missile Range. Space-General has developed a family of the high-altitude research rockets as a follow-on to the 15-year-old Aerobee series. *See p. 24.*

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†U.S. Reg. Pdg.

38,572 copies this issue

That Engineer Shortage

To the Editor:

I have recently read the letter in M/R, Feb. 5, signed "An Engineer's Wife," regarding the engineer shortage in the industry.

In one particular aspect, I must agree with her. This is in regard to the requirement of college grade-point average.

For three years I have been working as a technical writer. I have reason to believe that I qualify for this position, for I have written manuals and specifications on the *Sergeant, Atlas* launch and support systems, and various other systems. During these three years I have been engaged in contract technical writing, i.e., "job shopping," as opposed to permanent employment with the larger firms. The reason is lack of formal education: my only diploma is one from high school. I cannot qualify for work in the technical publications department of any major company. Yet I can and do qualify to come to the premises of these organizations, on the payroll of a contract engineering firm, and write, edit, and supervise the publication of manuals.

It seems to me that if industry wants to attract qualified men to fill the need for engineers (in all categories), it should lower the barrier it now has against men with either no college at all, or college but no degree. There are many such men doing a sterling job in contract engineering who would much rather be elsewhere but cannot be. I have found that this diploma-fetish rests mainly in the personnel offices of industry. The engineering and/or publications departments don't much care where a man came from so long as he's able to do the job at hand. This feeling on the part of the personnel interviewer may account, in part, for the so-called shortage of engineers. There is no shortage in contract engineering.

(Name withheld on request)
San Francisco

To the Editor:

Men with 20 or more years of experience in electronics, though often lacking a degree, are another valuable source of know-how. Their experience, gained through years of working with equipment in the field, could be used advantageously in areas such as system and intersystem compatibility, logic of approach to a problem, and field operation and maintenance.

Such men, though they cannot replace the new graduate engineer, are a largely untapped source of knowledge which could furnish valuable guidance to the new engineer while he is gaining experience.

The problem facing us, nationally, is two-fold: how to help more high school graduates obtain their degrees in engineering, and how to fill the gap until that is accomplished. Any successful solution must be adopted nationally.

As suggested in Mr. A. T. Strickland's letter (M/R, Feb. 12), we must provide a means for earning adequate wages during summer vacation, as well as while in college. If industry would sponsor more qualified engineering enrollments, paying most of their expenses pending graduation, there would soon be no shortage of engineering graduates. Many qualified young men would be happy to take advantage of such an opportunity and repay their sponsor out of their first years of employment after graduation.

C. N. Savage
Melbourne, Fla.

To the Editor:

The doubling of the present engineering and scientific manpower (assuming it could be done) by 1970 would be the coup de grâce of an already declining profession. The eager "youngster out of school who has taken the latest courses" is but a walking encyclopedia of cookbook solutions and procedures. It takes some time (forever for some unfortunates) for the true realization of what he has learned. It takes still longer to begin to apply this knowledge to new and unknown areas.

The colleges and universities cannot teach the technology of tomorrow, they can only teach what has already happened; but vastly more important, they do teach the *unchanging scientific* fundamentals. The thermodynamic textbook of today offers few advantages over the 1940 version. The same is true of most of the engineering sciences, mechanics, mathematics, etc. Only with a firm foundation and the maturity to recognize and apply these fundamentals is true creativity possible.

The far too common stereotype of engineer today is encouraged to remain behind his cookbooks to forever apply the history of past methods to the problems of today, often without fully realizing why it was thus done in the past. He is denied the task-direction and supervision necessary to develop a scientific maturity and the ability to supply the fundamental principles to create rather than rearrange.

The new engineer needs proper supervision and task opportunities to obtain this maturity. The B.S. is nothing more than a P.L. (permit to learn). The engineer who, by misuse, is denied this advanced instruction has only received half his education. The older scientists and engineers, who may have received this education, are presently turned down; not because their knowledge is outdated, but because their cookbooks are outdated. The 1970 crisis could best be solved by doubling the present engineers, rather than doubling the number of "learner permits." This respon-

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sibility rests mainly on the management, and must be realized else the cooks spoil the broth.

(Name withheld on request)
Boulder, Colo.

Patent Equities

To the Editor:

In Letters to the Editor, M/R, Feb. 19, concerning the Patent Rights controversy, two writers submitted opposite views —that the organization, whether it be government or industry, which provides the money for creative talent is, and is not, entitled to patent control.

May I submit that the most discriminating factor determining patent rights is neither money nor creative talent. Industry and government have reached a point where their paid talent is producing diminished creativity. This is not because these inventors or industries are not being paid adequately. The real "fly in the ointment" is the sublimation of payments for performance of operations of immediate importance. There are so many immediately important projects, that an endeavor which may be important in the future is often physically impossible to pursue in the location having the most experience. Thus, it is necessary that someone else with less experience take the chance of investing capital for a sufficient parallel effort which entitles them to a slice of any future profit.

The question is then very simple. Do they really get a slice or are they entitled to full ownership? First, it must be a slice, and second, a procedure must be set up to determine the size of the slice *before* the fact, on the basis of its value *after* use. Without this, the effort is unchanneled.

The value of an "idea" is non-existent until it is used. Nevertheless, the inventor who produces nothing of practical value for years, but will—he hopes—must still eat. That he should get paid as much as an equally conscientious person who has produced useful ideas, is not the question at all. The question is, how much more should persons or industries be paid for a specific, created value? When this is categorized in advance, the direction of effort is obvious.

The converse to the above, which is equally important, is the fact that a person or industry concerned with new developments must take into account, exactly, their debt to "someone else's risk," with the *degree* publicly established in advance. This is to say, that a risk exists until something useful, not necessarily a product, is achieved, and the costs up to that point of any development are a debit of the originator, which can be measured and which must be cancelled before any mutual reward can be expected.

If organizations, government or industry, really want to put money to work, it is up to them to initiate mutual incentives by pre-categorizing patent equities according to performance.

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The Countdown

WASHINGTON

Live Launch of Skybolt Due Soon

First "live" launch of the Douglas ALBM *Skybolt* from a B-52 is due shortly on the Atlantic Missile Range. Initial powered flights, to test aerodynamic stability, will use an existing inertial guidance system developed by the Kearfott Division of General Precision, Inc. Operational *Skybolts* will be equipped with a stellar-inertial guidance system under development by Nortronics Division of Northrop Corp. Use of the existing guidance equipment is said to have cut several months from the test program.

Morale Problems on Polaris Subs

The Navy is keeping it quiet, but early cruises of the *Polaris* submarines have turned up some serious morale problems among crews. Divorce rate is said to be climbing. In one disturbing incident, a crew member was not told of a death in his family until the sub returned from station.

New Dyna-Soar Pads for Cape

Three *Titan III* launch pads to be used in the *Dyna-Soar* program will be built for the Air Force at Cape Canaveral. Each will be an integrated facility in which the booster and its *Dyna-Soar* payload will be serviced in an industrial area and then moved by rail to the launch pad. Although no decision has been made, AF may build the pads on new land acquired by NASA in order to make use of space agency facilities.

Long Path for NASA Budget

Hearings on NASA's Fiscal '63 budget will run through most of the current session of Congress. Earliest the House Space Committee can take action on the bill is late April or early May. Hearings then will begin in the Senate. Formal approval of the appropriation thus cannot come until near the end of the session.

Name Change for Dyna-Soar?

Watch for a change in the *Dyna-Soar* name. Top DOD officials are pressing for a name change for the manned space vehicle in order to emphasize the strictly research nature of the program. Most likely: an X-number.

Solids Miss the Moon Boat

Some of the industry's top proponents of large solid boosters now concede privately that foot-dragging on the program means the solids no longer can be ready in time for the first U.S. manned lunar landing missions. The Air Force, meanwhile, is making an effort to obtain public NASA support for development of large solids. Without it, AF officials feel, they may have a hard time squeezing the necessary funds out of Congress.

Atlas Shot Boosts Enthusiasm

Even the most experienced *Atlas* observers were enthused over the initial *E*-type launch from Vandenberg AFB. The additional 30,000 lbs. thrust produced a noticeable difference in acceleration.

Delay in Titan I Training Program

Pace of training SAC's *Titan I* crews has been slowed down by the need for refurbishing of the silo and elevator areas after each launch. Refurb parts are provided in kit form but the program has hit delays in some "unexpected" requirements.

First West Coast Minuteman Firings

First *Minuteman* firings from Vandenberg AFB now are slated for late this fall. Two dummy vehicles, including the transport-erector systems, already are at the base for training SAC crews in placement of the missile in its silo. Six silos will be used in the program, the highest-density missile crew training program ever attempted at Vandenberg.

INDUSTRY

Skyrocketing Skybolt Costs

Watch for a switch to an incentive-type contract for the GAM-87 *Skybolt*. The ALBM is costing much more than anticipated. An incentive contract would force out the true cost. DOD officials then would have accurate cost information for a decision either to increase funding or to cut the number of missiles programed.

Navy Investigating Variable Thrust

Variable-thrust propulsion units producing some 20,000 lbs. of thrust have been fired at the Naval Ordnance Test Station, China Lake, Calif. Test system used four NOTS-developed 0-5000-lb. variable-thrust units with UDMH and red fuming nitric acid as propellant.

Greatest Show on Earth

Attendance at this year's IRE meeting in New York, March 26-29, is expected to exceed 70,000. This would make it the largest technical gathering ever. Among items on the program: a General Electric-sponsored affair with the off-Broadway title, "How to Succeed in New Rectifier and Silicon Controlled Rectifier Applications Without Really Trying."

INTERNATIONAL

Russians Studying Powered Re-Entry

A Soviet publication says future re-entry methods may include winged vehicles equipped with engines. Aerodynamic heating problem could be solved by controlling the speed and direction of re-entry and the vehicle would be usable for more than one flight. The Russian source says advanced rocket aircraft, already approaching 6000 km/hr. or 25% orbital speed, might be the forerunners of these vehicles. This suggests the Soviets may have a program similar to the U.S. *X-15* project but with the ultimate goal of extending the craft into a space system.

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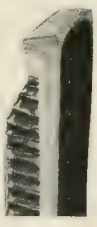

Cross section showing exit skirt molded of Prepreg, R/M Style 40RPD Pyrotex® felt.

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The Missile/Space Week

Shots of the Week

NASA's first *Orbiting Solar Observatory* was successfully launched from Cape Canaveral by a *Thor-Delta* rocket on March 7.

The 458-lb. satellite, carrying 13 experiments designed to give scientists their first undistorted data from the sun, was launched into a near-circular orbit (apogee 370 mi., perigee 340 mi.). Its angle of inclination to the equator was 33 degrees.

Dr. Hugh Dryden, NASA Deputy Administrator, said after the shot that the satellite was "in many respects one of the most advanced" ever launched and its entry into orbit opened a "new phase" of space exploration.

Ball Brothers Research Corp., Boulder, Colo., was prime contractor for the satellite.

The launching of *OSO-1* was the first of a series of solar observatory vehicles to be launched during the next 11 years, a period covering one full "sun spot cycle".

Hoped-for result of the *OSO* experiments is a method for reliably predicting solar flare.

In other shots:

• The Army test-fired its *Nike-Zeus* antimissile missile March 5 for the first time from Kwajalein Island against a simulated ICBM.

Using data programmed into the *Zeus'* target intercept computer to simulate the re-entering ICBM, the successful test was in anticipation of test firings against ICBM's launched from Vandenberg AFB, 5000 miles away, later this year.

• A Navy *Polaris A-2* was launched from Cape Canaveral March 1, carrying a new lightweight guidance system developed by Massachusetts Institute of Technology for eventual use in the 2800-mile-range *Polaris A-3*.

The missile hit its target 1500 miles downrange.

The new intertial guidance platform, slightly larger than a basketball, weighs one-third that of the *A-1* guidance system and will thus permit a correspondingly heavier warhead.

• Three *Nike-Cajun* rockets were launched from Wallops Island, Va., March 2, in a series of tests to measure atmospheric conditions at high altitudes.

Most spectacular of the tests was one in which sodium vapor was discharged into the atmosphere—starting at 26 miles above the earth and continuing until the rocket reached an altitude of 84 miles.

• The Air Force successfully recovered in the air a data capsule ejected from *Discoverer XXXVIII* after four days of orbiting the earth.

It was the eighth successful air-snatch of *Discoverer* capsules. Four others have been recovered by AF frogmen.

The capsule contained samples of various metals which the AF is testing to determine the effects of radiation on metals.

• An AF Martin *Mace B* missile was successfully launched from Cape Canaveral on March 2, in the final firing in the *Mace* system operational test and evaluation program.

Lockheed Gets AF Solid Award

Lockheed Propulsion Co. has won a $2-million contract from the Air Force Space Systems Div. to build and conduct feasibility tests on a segmented solid-rocket motor 120 in. in diameter.

The big motor, using a propellant already developed by Lockheed, will be the first project to undergo feasibility testing at the company's test facility at Potrero, Calif.

Robert F. Hurt, president of Lockheed Propulsion, said his scientific staff would press the fabrication and test firing of the motor "at the earliest possible date consistent with sound scientific judgment."

AT&T Opposes ComSat Plan

American Telephone & Telegraph Co. told Congress that it opposes the Kennedy Administration proposal for a broadly owned commercial communication satellite system.

An official of the firm told the Senate Space Committee that the satellite corporation should be owned solely by communication carriers.

Vice President James E. Ding-

man said that the carriers had earned the right of ownership because of past service and development of communication satellites.

He said they could develop the system faster and more effectively if there were no public stockholders.

Later, the Administration charged that it was inconsistent for AT&T to charge that ownership should be limited to big communication carriers.

Dr. Edward C. Welsh, Executive Secretary of the National Space Council, pointed out that few companies have as broad ownership as AT&T.

"I have been further advised that this widely distributed stock ownership has neither caused that company to be particularly ineffective nor has it been the reason why communication rates are as high as they are now," Welsh said in a statement filed with the committee.

Van Allen Belt De-fanged?

The Van Allen Radiation Belt may no longer be a problem in manned space travel, the Air Force reports.

An AF announcement said that data from an *Agena* satellite indicates that the belt is only one-half as big in area of major radiation concentration as was originally surmised, although it is perhaps six times as "hot."

The AF said that the satellite provided the first continuous data on the actual size and intensity of the inner belt.

HEPDEX (for High Energy Proton Detection Experiment) revealed that the zone of significant radiation covers approximately 20 degrees on either side of the magnetic equator.

Earlier, maximum radiation in the belt was thought to be equal to 100,000 protons passing through the area of a four-cent stamp each second.

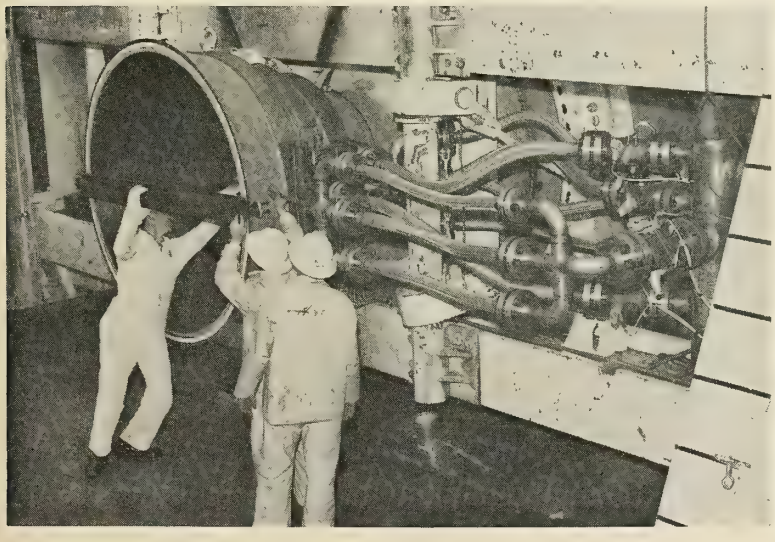
HEPDEX, however, revealed that the radiation was equal to 600,000 protons passing through the stamp per second.

This means that the inner belt is much "hotter" at its center than originally thought, but it would take nearly a week of continuous exposure at this rate to cause death.

JFK Sends K Some Specifics

President Kennedy wrote Soviet Premier Khrushchev a letter proposing some specific programs of joint U.S-USSR space cooperation.

Details of the letter were withheld pending its arrival in Moscow.



Largest Firing of TVC System

LIQUID INJECTION THRUST VECTOR CONTROL checked out successfully in the firing of Aerojet-General's 600,000-lb.-thrust engine on Feb. 17. The secondary fluid was not identified. Aerojet has flown liquid-injected vector control systems in Polaris test vehicles at Cape Canaveral. The system marked the largest test firing of a TVC system. United Technology used a liquid injection method in its large booster firing last December. Aerojet's unit was deemed completely satisfactory during the 98-second test.

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AF Explains Added Base Costs

Zuckert blames concurrency of construction and missile development—plus lack of previous experience

by James Trainor

AIR FORCE'S management of ICBM activation is under heavy fire before Congress for multimillion-dollar cost over-runs. This, coupled with earlier disclosures of base delays resulting from poor Air Force and Army construction management, has once more raised questions about the concurrency concept.

One question certain to be asked again: Could the missile manufacturers such as Convair and Martin have done a better job of managing the programs than the Air Force-Space Technology Laboratories complex?

A Senate committee was told last week that construction of *Atlas* and *Titan* ICBM hardened sites concurrently with development of the missile systems has resulted in a $225-million over-run.

Inexperience in cost-estimating a program with "no parallels in past experience" also was held partly to blame.

Appearing before a special, one-day session of the Senate Preparedness Investigating Subcommittee, Secretary of the Air Force Eugene M. Zuckert said that he had been both "surprised and concerned" when he became aware of the mounting ICBM base construction costs.

Even now, the Secretary said, there is "no assurance that $225 million can do the job" since this figure represents just what can be foreseen at the present time.

• **Time critical element**—Under the prodding of Sen. Stuart Symington (D-Mo.), Zuckert pointed out that, in the base construction program, time was the most critical element.

"Missile bases had to be started long before the missiles they were to house had been flown, much less fully tested," he said, "if both were to be ready at the earliest possible date, as the National Security Council had directed."

As a result, he said, changes were made in the hardened bases as required —but the paperwork was neglected in the press of time. Consequently, it was some months before contractors were able to submit documented cost proposals showing the impact both in time and material of authorized changes.

When the contractor cost-estimates were submitted in late 1960 and early 1961, AF contracting officers, Zuckert said, "found it difficult to credit these estimates with much more than an inclination on the part of the contractors to protect themselves."

However, as the impact costs were assessed, it was realized that "if contractors' proposals were generally high, ours were often low," Zuckert added.

• **Congress warned by DOD**—As the extent of the change costs became more apparent to both the Defense Department and the Air Force, Assistant Secretary of Defense (Installations & Logistics) Thomas D. Morris told the subcommittee a letter outlining the situation was submitted to Congress.

Specifically, Morris testified, Deputy Secretary of Defense Roswell Gilpatric notified the Senate Subcommittee on Military Construction on July 10, 1961, that "because of the uncertainties of costs in change orders as well as claims, it appears that the final estimates of the program will further exceed the specific authorizations and appropriations made for this program."

Air Force estimates for construction of the *Atlas* and *Titan* sites were originally set at $996.2 million, then jumped to $1.048 billion, and are now pegged at $1.272 billion. In addition, $66 million was re-programed from personnel accounts to cover site construction costs.

The additional $225 million requested in the FY '63 budget represents no new starts and was broken down by Zuckert as: $130 million for settled and validated claims, $25 million for *Titan II* adjustments, $30 million for identified but unstarted work, $13 million for increased government costs, and approximately $25 million for future costs.

Most of this money will be spent on the *Atlas F*, *Titan I* and *Titan II* sites. The latter, according to Maj. Gen. Thomas Gerrity, Chief of the Ballistic Systems Division, can be expected to produce the greatest number of design changes, since the system is now entering the critical electro-mechanical construction phase. Also, he said, changes can be expected in the silos as the flight test program gets under way.

• **Outside firm engaged**—Considerable criticism was voiced by Senator Symington over DOD's decision to engage an outside management firm to investigate and analyze the management structure of the ICBM site construction program.

"I have sufficient pride in the government," Symington said, "to feel that they are capable of doing this." In effect, he said, this amounts to a DOD vote of no-confidence in the Air Force.

The firm—Arthur F. Anderson & Co. of Chicago—has been at work since early January conducting an on-site audit, Morris told the subcommittee. This part of the audit—concerned with evaluating estimated total costs—will be submitted to DOD by April 1. The remainder—covering the managerial and administrative practices—will be finished by June 1.

• **Strikes not a factor**—Although the steel strike of two years ago significantly delayed the site construction program, Gen. Gerrity told the committee, strikes since that time—particularly in the last year—have not been a major problem.

Gerrity also made a plea for more flexibility in appropriations "when construction is a part of a weapons system." This would allow him, he said, to put some money into research and development on construction of the bases.

In response to a question from Sen. Symington, Gerrity said that he would recommend more flexible contracting procedures in future site construction.

• **More inquiries coming** — Some companies have deliberately quoted below cost and, after winning the contract, have sought to recover not only costs but a profit through change costs, Sen. Symington asserted.

The government, therefore, should have the right to require the contractor prove that the cost is related to a change, he said.

Presumably, this practice of "buying in" will come under close scrutiny by Sen. McClellan's Senate Investigating Subcommittee later this month.

Another investigation into the ICBM construction costs is slated for Rep. Carl Vinson's House Armed Services Committee during hearings on the Administration's FY '63 Military Construction Bill. ⁂

In budget hearings . . ,

NASA Outlines Long-Range Launch Plans

NASA WILL LAUNCH some 84 unmanned scientific satellites in the 1962-65 period in support of its manned lunar landing program.

In addition, approximately 200 sounding rocket probes are scheduled.

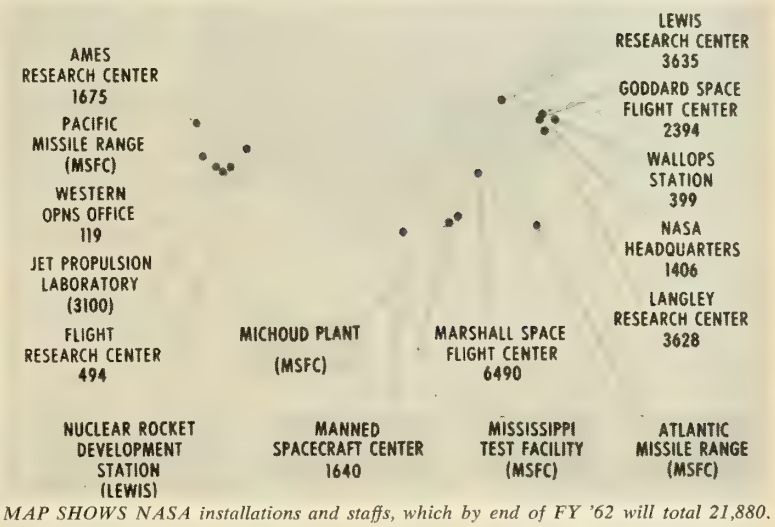
Dr. Homer E. Newell, head of the Office of Space Sciences, revealed the heavy schedule in testimony before a House Space Subcommittee holding public hearings on NASA's Fiscal 1963 budget request.

Dr. Newell also disclosed that NASA has decided to go ahead with the development of the *Prospector* spacecraft. Engineering work will begin early this year and the first *Prospector* launches are slated for 1965.

Turning to the even more distant future, Newell said that in 1968 it is planned that the *Voyager* spacecraft, launched by a *Saturn*-class vehicle, will orbit the planet Mars. A heavy-landing capsule may also be carried on this mission.

Between 1968-73, flights will be made toward the sun, out of the plane of the ecliptic, toward outer planets such as Jupiter and perhaps in toward the sun to Mercury.

Included in the 1962-65 unmanned satellite schedule of launchings are seven *Rangers*, nine *Surveyors*, three *Prospectors*, four *Mariner R*, eight *Mariner B*, one *Voyager*, 29 *Explorers*, 10 *Orbiting Geophysical Observatories*, 11 *Orbiting Solar Observatories*, and four *Orbiting Astronomical Observatories*.



MAP SHOWS NASA installations and staffs, which by end of FY '62 will total 21,880.

Newell told the subcommittee that the study of harmful radiation in space, and unmanned investigation and exploration of the lunar surface were the primary purposes of the space sciences program.

The lunar exploration schedule calls for a rough landing with the *Ranger* spacecraft this year. In 1964, the *Surveyor* spacecraft will make the first soft lunar landing attempt.

The first *Surveyor* lunar orbiter is also planned in 1964. This spacecraft is to provide the first reconnaissance and mapping of the moon and in addition will provide an anchored monitoring station at the moon's orbit for measuring radiation. In the 1965-66 period, the *Surveyor* mission capability will be extended to *Prospector,* with a capability to land anywhere on the lunar surface and to employ a roving surface vehicle for site surveys.

A landing platform, an ejectable retro rocket, and various payloads would comprise the major modules in the *Prospector* spacecraft.

In the interplanetary field, design and development of the *Voyager* spacecraft is scheduled to begin this year,

NASA Sets Up Separate Atlantic, Pacific Launch Centers

NASA HAS REORGANIZED its launch operations facilities at the Atlantic and Pacific Missile Ranges into two independent field installations.

The Launch Operations Directorate —located at Cape Canaveral—will now be known as the NASA Launch Operations Center. The new center will be under the direction of Kurt Debus and will report directly to D. Brainerd Holmes, director of the space agency's Office of Manned Space Flight.

The NASA Test Support Office at the Pacific Missile Range will be established as the NASA Pacific Launch Operation Office. It will be under the direction of Lt. Cmdr. Simon J. Burttschell and will report directly to Dr. Homer E. Newell, head of the Office of Space Sciences.

Associate Administrator Robert C. Seamans, Jr., said the Launch Operations Center will service all NASA programed launches from Cape Canaveral, but will report to Holmes to insure immediate response to the many jobs involved in the manned lunar landing program.

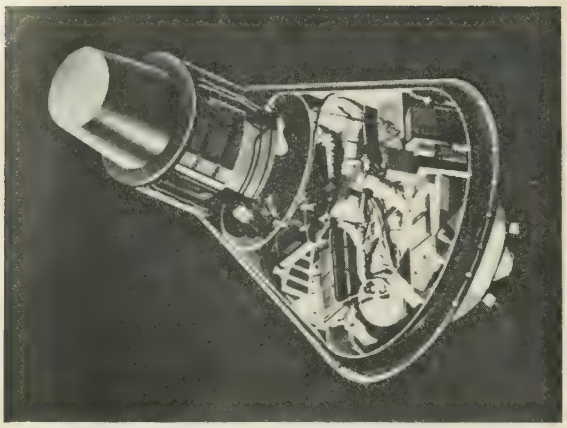
"The center at the Atlantic Missile Range consolidates in a single individual all of NASA's operating relations with the Air Force Commander at AMR," Seamans said.

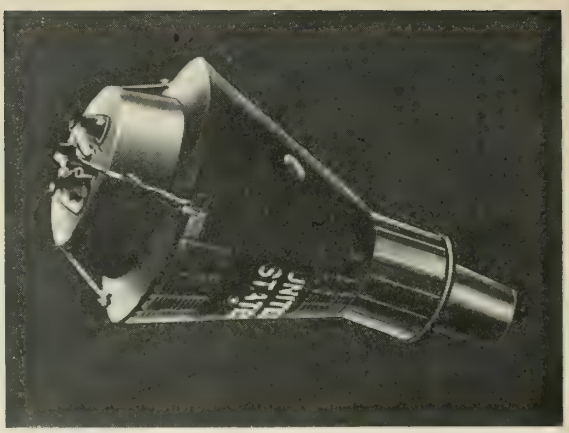
"In addition, the single organization will insure the best possible planning for and use of common facilities for equipment, services and support personnel for launchings from Cape Canaveral."

Seamans said similar but more limited arrangements will be made at the Pacific Missile Range. The new center will report to the Office of Space Sciences because that office has most of the NASA launches scheduled from PMR.

Both of the launch centers were formerly part of the Marshall Space Flight Center. To replace Marshall's old launch operations setup, a new Launch Vehicles Operations Division has been established.

It will be directed by Dr. Hans F. Gruene.





NASA PHOTOS of three-orbit and 18-orbit Mercury capsules illustrate enlarged service pod in the latter, necessary to support a one-day manned mission. It will hold additional attitude control equipment, life support and battery systems.

Newell said.

• **Vehicle outlook** — Turning to launch vehicles for the unmanned scientific program, Newell said that:

—*Scout*—Payload of the *Scout* booster will be increased to 240 lbs. in a 300-mile orbit later this year. NASA has ordered some 30 of the vehicles and 23 missions have been scheduled through 1963.

—*Centaur*—The first launch is still scheduled for early this year. The ignition problem has been licked. Protecting the very cold liquid hydrogen in the *Centaur* tank from boiling away during flights in space lasting many hours continues to be a critical problem. NASA is also pushing a product improvement program to increase the weight-carrying capability of the vehicle.

—*Agena* — Twenty-eight missions are currently planned for NASA *Atlas-Agena* and *Thor-Agena* Vehicles. NASA also expects to use the *Agena* vehicle into the 1970 era.

The House Space Committee has split up hearings on NASA Fiscal '63 budget request between four subcommittees—one for each of NASA's four program offices.

• **Nuclear rocket plans**—Details of how a nuclear-powered rocket could be used to achieve a manned landing on Mars or Venus were revealed before the subcommittee considering the programs of the space agency's Office of Applications.

Harold B. Finger, director of the space nuclear propulsion office, said that the nuclear-powered space vehicle would be assembled in or placed into a 300-mile earth orbit.

It would fire from the earth orbit with a full load of hydrogen propellent. The vehicle would be established in a Mars orbit and a chemically propelled landing craft would land three men on Mars. The men would then rendezvous with the orbiting spacecraft, using a chemically propelled vehicle to take off.

The entire trip would take 400 days, including 40 days at Mars.

The weight of the nuclear-powered vehicle in the earth orbit would be 1 million lbs. An all-chemical vehicle, Finger said, would weigh 10 times as much.

Other pertinent comments on the nuclear rocket program included:

—The most difficult problem which must be solved is the development of a reactor which will withstand the high temperatures that are required at the imposed thermal stresses and flight loads. Also, jet nozzles capable of withstanding the high-temperature jet must be developed. This involves the solution of materials problems, fabrication problems, and the accumulation of basic heat transfer information.

—NASA plans this year to test reactors at the rate of one every two months in order to select a reactor in 1962 for incorporation into the *NERVA* engine. A selection this year is imperative if the proposed 1966-67 flight schedule is to be met. In order to insure the high reliability which must be proved before flight testing, 30 to 40 reactor engine assemblies will be needed to perform various tests.

—Nuclear rocket test stands will differ sharply from chemical ground firing stands. The nuclear engine will be brought to the stand on a railroad car and will be automatically connected to the stand. Heavy shielding will enclose the engine during test operations to reduce radiation levels. ⌗

Nuclear Tests to Sharpen Missile Deterrent

RENEWED ATMOSPHERIC testing is expected to substantially increase the effectiveness of missiles in the U.S. nuclear arsenal.

The major area of advancement expected from the shot series—announced last week by President Kennedy—will be the accumulation of definitive data on the high-altitude effects of nuclear weapons. This is essential to the development of an antimissile missile and to the determination of the effectiveness of radar and communications in this environment.

Proof-testing of weapons already in the arsenal—such as *Polaris, Sergeant, Atlas* and *Titan*—should give "an increased capability to employ these weapons systems effectively by more accurate measurements of weapons effects," says Secretary of Defense Robert S. McNamara.

Development-testing of novel concepts for nuclear weapons may also provide improved yield-weight ratios. Likely to be of particular concern in this area are the "clean" thermonuclear bomb and the neutron bomb.

In the area of nuclear effects, the U.S. expects to be able to find out exactly what happens to a hardened ICBM site after the explosion of a nuclear weapon. This could lead to increased survivability and "second-strike" capability for our retaliatory forces.

• **Not enough?**—The President's decision to end the three-and-a-half-year U.S. moratorium on atmospheric testing was based on the "major gains" made by the Soviets in their series of tests last fall. Significant advances were made by the Russians, Kennedy said, in the areas of high-altitude effects and yield-weight ratio of their strategic nuclear weapons.

In spite of Kennedy's announcement, concern was voiced by some members of Congress that the series of tests would not be comprehensive enough.

Martin will build SNAP 11 . . .

AT&T To Aid NASA's Engineering

AMERICAN TELEPHONE and Telegraph Co., has been selected to provide system engineering support for the U.S. Manned Space Flight Program.

In another important contract action, Martin Co. was named by the Atomic Energy Commission to build a *SNAP 11* nuclear-powered electrical generator for use in NASA's *Surveyor* spacecraft.

The space agency announcement said that the AT&T contract would give NASA a broader base on which to make crucial decisions in Projects *Apollo* and *Gemini.*

No money figure was disclosed, but NASA said that some 200 technical, scientific and management personnel will work under the contract.

The AT&T organization to which the personnel will be assigned will work directly with the office of systems in the space agency's Office of Manned Space Flight.

• **Here and now**—Main purpose of the contract, NASA officials report, is to give the agency an immediate systems engineering capability. It will be some time, they point out, before NASA's systems engineering office is operating at top efficiency.

"We must find rapid solutions to some of the most complex technological problems ever faced," Administrator James E. Webb declared.

"We are building the technical capability in our NASA organization to perform a large part of the system engineering studies we need. But with this contract, NASA will have the most skilled and experienced specialists immediately available to help meet our urgent time schedules," he continued.

• **Latest SNAP**—*SNAP 11*—which Martin will design, build and ground-test—is the newest thermoelectric device for spacecraft propulsion. It will weigh about 30 lbs., including shielding to protect spacecraft instrumentation. It will provide a minimum of 18.6 watts

(Continued on page 36)

Russians Release Photos of Rocket, Missile Sub

THESE PHOTOS recently appeared in Red Star, and were released to the Western press. Picture at left shows "a ballistic rocket ready for launch." At right, a "rocket-carrying submarine boat." No other details were disclosed.

BULLPUP B'S on Navy's A4D Douglas Skyhawk. It's reported new Skyhawk will carry more than three.

Production tripled . . .

Cost-Cutting Wins New Bullpup Awards

Martin trims costs by more than two-thirds, gets fresh orders including first for output of Bullpup B

by Hal Taylor

ORLANDO, FLA. — Mass production of the *Bullpup* missile has enabled Martin Co. to triple production while slashing costs by over two-thirds.

As a result, Martin has been awarded a new contract for more *Bullpup A*'s and first production runs of the *Bullpup B*.

The award, announced last week, runs through June, 1963, and will ultimately be worth about $16 million. It was disclosed that the air-to-surface missile will become standard armament on four additional aircraft. Numbers carried by two other aircraft will be increased.

The Navy said the *Bullpup* will be carried by the Chance Vought F8U-2N Crusader, the McDonnell F4H Phantom 88, the Grumman A2F Intruder and the North American A3J Vigilante. It also was reported that the new Douglas A4D Skyhawk will carry more than the three *Bullpups* carried by earlier versions.

At the same time, the Air Force announced it will increase *Bullpup* capacity of its Republic F-105 Thunderchief from two to four missiles.

Ahead lies the promise of additional production and new contracts. The firm is already developing several different versions of the nuclear-warhead *Bullpup* which the Air Force is interested in. The new missiles will have different types of guidance systems and missions than the missiles now in production.

NATO is also expected to utilize various versions of the air-to-surface missile.

"The *Bullpup* story is a tribute to industrial preplanning by Martin and the ability of the missile/space industry to meet national defense needs," according to Lee Schaidt, Martin's ASM Program Director.

• **Timetable** — Its history verifies this. Research and development on *Bullpups* began in 1958. Following completion of the test flight series, it went into limited production with funding by the Navy. Later, the Air Force began to purchase the missile.

On July 25, 1961, President Kennedy told a nationwide television audience that the Berlin crisis necessitated an immediate step-up in defense preparedness. The emphasis, he said, would be on increased ground forces and tactical missiles.

On Aug. 29, the Navy and Air Force signed a contract for accelerated production of the *Bullpup A*. Four months later, Martin had tripled its output. Along the way it also cut overall production costs by 70% and manhours per missile by 20%.

This is the step-by-step listing of events:

• President Kennedy's speech July 25, 1961.

• Verbal request from Navy for acceleration plan.

• Acceleration plan complete.

• Vendors and subcontractors alerted to possible acceleration plan.

• Acceleration plan presented to Navy.

• Authorization to accelerate August 31, 1961.

• Production schedules revised Sept. 8, 1961.

• Vendors accelerated Sept. 8, 1961.

• Accelerated deliveries began Sept. 29, 1961.

• Peak rate achieved (300% increase) Dec. 29, 1961.

• **Whole family**—*Bullpup* is an air-to-surface guided missile which includes several different types of systems. The Navy's *Bullpup A* and the Air Force's *GAM83A* are the same.

The missile is 11 ft. long, 1 ft. in diameter and delivers a 250-lb. conventional warhead. Its range is three to six miles.

Bullpup B is also a Navy missile. It is 13.6 ft. long and weighs 1785 lbs. Its range is 3 to 9 miles and it carries a 1000-lb. conventional warhead.

The nuclear *Bullpup* or *GAM83B* is a classified Air Force weapon.

Bullpup as a weapons system has two prime advantages.

1. It requires very little ground support equipment. All *Bullpup* versions are delivered "test free" and can be loaded on aircraft ready for firing in about five minutes using only normal bomb handling equipment.

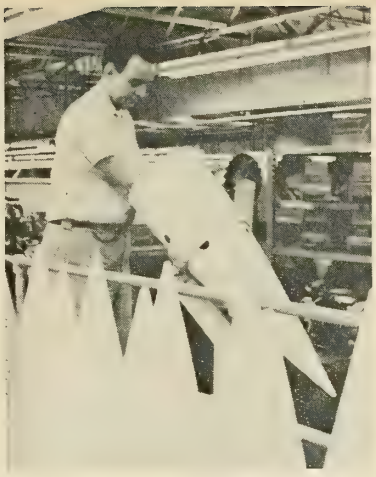
2. It chalked up a 90% reliability record. It is launched more than two miles away from surface targets such as airfield installations, trains, or truck convoys. Tracking flares in the tail enable the pilot to follow the missile while sending commands for changes in direction through a simple "up," "down," "left," "right" switch in the cockpit. The missile reaches speeds near Mach 2.

Bullpup thus fits the requirements of limited war situations. Aware of this, Martin officials anticipated the Navy order for more *Bullpup A*'s and its preparations were well advanced when official word was received.

• **Alternate sources key** — One of the major steps was a series of field trips to prepare the system's subcontractors for the accelerated effort and to determine if they were capable of achieving it.

When the acceleration order came, subcontractor output met the production goal in 45 days.

"We whipped the problem by having at our disposal alternate sources of supply among our approximately 225



MARTIN engineer checks Bullpup nose.

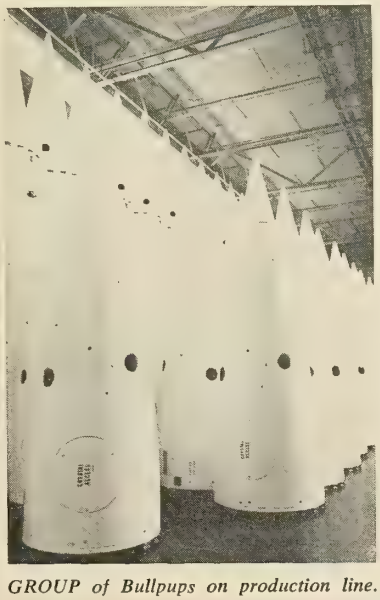
subcontractors," George L. Forest, procurement manager, said.

"This gave us a backup if one's production failed. We also used it to increase competition and cut costs," he continued.

The field trips had three primary interests, vendor tooling, manufacturing procedures and sequencing of operations.

Another major problem which had to be met was that of "control." Vernon Carre, manufacturing manager, put it bluntly: "When you're going at a high rate of production, you have to have everything there when you need it."

The solution was quite simple. A visual control room was set up in which every component, the amount needed, the sources, needed date, and expected delivery date were listed.



GROUP of Bullpups on production line.

Thus, Martin personnel were able to tell in a matter of minutes just what the status of any component was.

Schaidt calls the *Bullpup* program a "team effort"—one in which the Navy, Martin and component manufacturers combined their efforts to meet U.S. national defense needs.

• **Success factors**—He cites the following reasons for the tripled production and the large cost savings:

—"*Bullpup* essentially was conceived as a highly reliable but simple and low-cost missile. Everybody concerned made it a fetish to stick by that goal."

—"We used good hand tooling right from the beginning and they paid for themselves in the first few months. Special tooling was also used early, so that when the acceleration order came our tooling was ready and no major additions or improvements had to be made. As a result, Martin spent only 1.3 per cent of the total value of the accelerated production in non-recurring costs to gear up for the new schedule."

—"We attempted to stear clear of specialized components. As a result, only about 10 components were specially designed for *Bullpup*. The rest were 'off the shelf' items, and we were able to obtain them from many different vendors."

—"We made a strong effort to minimize model changes. As a result, they are currently being made on a once-a-year basis. Thus our production line does not have to be slowed or shut down because of the introduction of a new model and revision several times a year."

—"We set up a good quality control system and made sure that we and the subcontractors met its goals."

Cost-cutting was also aided by a five-day symposium last October, attended by military representatives and 14 manufacturing firms involved in Martin's *Bullpup* and *Pershing* programs.

Earl R. Uhlig, vice president of finance for the firm, said, "This was a unique meeting. Its mission was to develop means of reducing costs of the two missiles. Out of the meeting came recommendations that amount to potential savings of more than $7 million."

Martin is currently working on three contracts for *Bullpup* production.

One is a $17-million contract awarded by the Navy and the Air Force for accelerated *Bullpup* production. The one-year contract will terminate on June 30, 1962.

The new $16-million contract covers the following year and calls for more *Bullpup A* output as well as the first production runs of the *Bullpup B*.

The last contract is a $2.2-million award for initial production of the nuclear-warhead *GAM 83B* missile. ⌘

MOBILIZING FOR THE MOON

About fifty-billion dollars will be spent in the next decade to develop the moon program—80% with industry.

NOVEMBER 27, 1961 — MISSILES AND ROCKETS published its NASA Issue, an in-depth study of the National Aeronautics and Space Administration's programs, projects, facilities, personnel, and contracting procedures—emphasis centered on NASA's future material and contract requirements. JANUARY 5, 1962 — Over 1,000 single copies ordered by companies and individuals. JANUARY 11, 1962 —NASA purchased 60,000 reprints of the editorial section of the NASA issue.

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Technical Countdown

ELECTRONICS

Antenna Pattern Coordinates Published

The Inter-Range Instrumentation Group at White Sands has recommended a standardized coordinate system and data format for representing antenna patterns. The two areas of the project are definition of a standard coordinate system for r-f radiation pattern representation, and establishment of a format for the display of antenna patterns over the entire spherical surface surrounding an antenna.

Alaskan Early Warning System Bids Sought

Letters of interest from firms seeking to bid on the procurement of an Alaskan Air Command Data Processing and Display System are being opened by the Air Force Electronic Systems Division. The system will supply accurate and timely early-warning information to both NORAD and Washington. It will consist of modified or specially designed equipment aimed at speeding track-data information insertion and accomplishing automatic large-scale display of radar data at four NORAD control centers.

New Glasses Promise Advanced IR Systems

Servo Corp. has been awarded an ARPA contract on long-wave-length infrared materials covering specific data on new infrared glasses discovered by the firm. The glasses are similar to Servo's arsenic trisulfide materials, but have a much wider range of optical characteristics. The new glasses can transmit IR energy beyond 16 micron wave length radiation.

Ruby Laser Optical Characteristics Revealed

Physicists at the Navy's White Oak Ordnance Lab have used a high-speed framing camera to examine the characteristics of operating ruby lasers. The red-light beam is actually a series of light bursts, lasting about a millionth of a second, spaced at intervals of several millionths of a second. The Navy group managed to get 82 individual frames during the beam emission period. Examination of the photographs shows in detail the nature of those parts of the crystal actually emitting light, and the activity as the crystal changes from one light burst to the next.

Accelerometer Principle Developed

Electrocapillarity can be used to determine acceleration forces with a sensitivity of 1 part in 100,000, say graduate researchers at Case Institute of Technology. A positively charged drop of mercury in a liquid under an electric field will migrate towards the negative pole. Its position can be controlled through external potential. Such a drop held stationary will move with the slightest acceleration. By measuring the amount of potential needed to maintain the stationary position, a correlation to actual acceleration can be made.

PROPULSION

Variable Thrust Units Fired at NOTS

Units generating up to 20,000 lbs. of thrust in a variable mode have been fired by researchers at the Naval Ordnance Test Station, China Lake, Calif. The test system used four NOTS-developed 0-to-5000-lb. variable thrust units, with UDMH and fuming red nitric acid as the propulsion system.

ADVANCED MATERIALS

Thick Films Under Study

Despite the current thin-film emphasis in computers, Remington Rand scientists are investigating the use of thick films said to offer higher output signals and simplify the following stages. The studies point to thick-film payoffs in reliability and reduced cost. This does not mean the company is ignoring thin-film technology. It believes thin films will increase operational speeds of computers and also cut costs.

Leak Detection Methods Funded

The University of Michigan will investigate under a NASA contract methods of leak detection in space vehicles. Prof. L. E. Brownell will evaluate current pre-flight leak-detection procedures and try to devise new methods for both pre- and in-flight applications through use of radioactive gases. Most promising is a system designed around krypton 85, a readily available by-product of nuclear reactor operations. The gas is a beta particle source, inert and readily soluble in LOX and other propellant constituents.

ASTRONAUTICS

Rendezvous Contract Under Negotiation

NASA is discussing a three-month, $250,000 contract with Chance Vought Corp. to look into space vehicle rendezvous. The primary task will involve a flight simulation study to explore an astronaut's ability to control an *Apollo*-type spacecraft. Chance Vought will probably use its new space vehicle simulation system (M/R, Jan. 1, p. 32).

Value Analysis Moves into Europe

British missile/space firms will be among those attending a seminar on value analysis in London during April. The cost-reducing management program, so successfully used by U.S. defense firms, is being exported by Value Analysis, Inc., a New York management consulting firm. The seminar will be the start of a large-scale cost reduction program in British industry.

New System To Vastly Improve Accuracy

Motorola will perform R&D, deliver and install three stations under $3.3-million award; acquisition in under 2 min.

THE NEW Goddard Range and Range Rate Tracking System is expected to provide at least an order-of-magnitude increase in tracking accuracy over the present Minitrack system.

Extensive studies performed over the last year by scientists at NASA's Goddard Space Flight Center have further resulted in a system which designers believe will minimize carrier power needs from vehicles up to lunar ranges, reduce received noise, and simplify satellite-borne tracking subsystems.

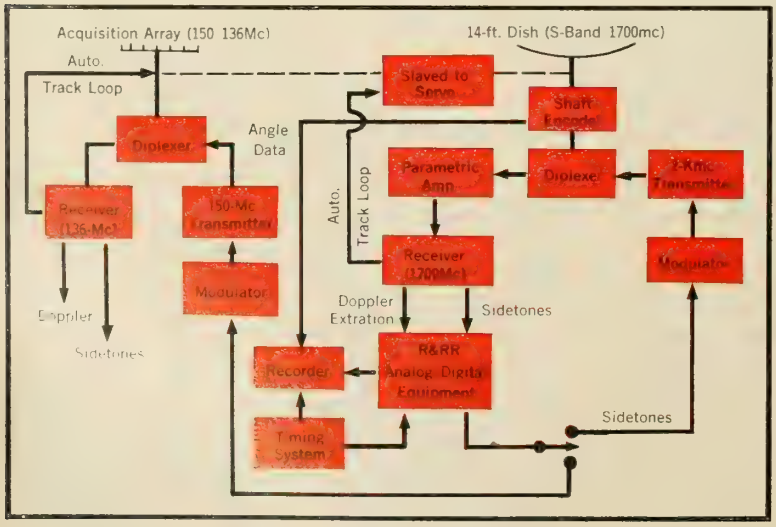
A conservative estimate is that total acquisition time will be less than 2 minutes. For earth-orbital and cislunar distances, a resolution of ±15 meters in range and ±0.1 meter sec. in range rate will be obtainable, Goddard officials say.

In January, Motorola's Western Military Electronics Division in Scottsdale, Ariz., was selected to develop and build the system. Under a $3.3-million contract, Motorola will perform the R&D and deliver three complete air-transportable ground tracking stations, as well as three flight transponders and associated electronics, and install the stations at prepared sites.

A key element in the multiple-tone ranging system will be the transponder. Being designed especially for this tracking application, it is intended to operate with these simultaneous interrogations from the independent ground stations. A design goal is to eliminate the detection process in the flight vehicle.

Transponder design is by Motorola. Program manager for the company is James Kirch. Initial system design was conceived at Goddard by E. J. Habeb, G. C. Kronmiller, Jr., P. D. Engels, and H. J. Franks, Jr.

System development installation and test are under the direction of C. A. Schroeder, chief of Goddard's Tracking Systems Division.



Simplified Block Diagram of Overall Range & Range Rate Ground System

• **Better accuracies needed**—Satellite tracking in the past was characterized primarily by a lack of electrical power—both for experimental equipment onboard and for space-to-ground communications and tracking signals.

Optical tracking, although it provided satisfactory accuracies, has been hampered by insufficient light (even when self-generated) and by vagaries of the earth's weather.

Slowly, new concepts in radio-frequency tracking evolved. Most successful to date, NASA reports, is the use of the interferometer principle to measure angular position range. The global Minitrack network is a multistation interferometric tracking system.

With a sufficient number of measurements from several Minitrack sites and the use of a good computer program, flight paths of orbital vehicles can be calculated and used to predict spatial position with respect to time.

At present, NASA can establish satellite angular position with respect to almost any particular global location up to 24 hours in advance to an accuracy better than 0.01°.

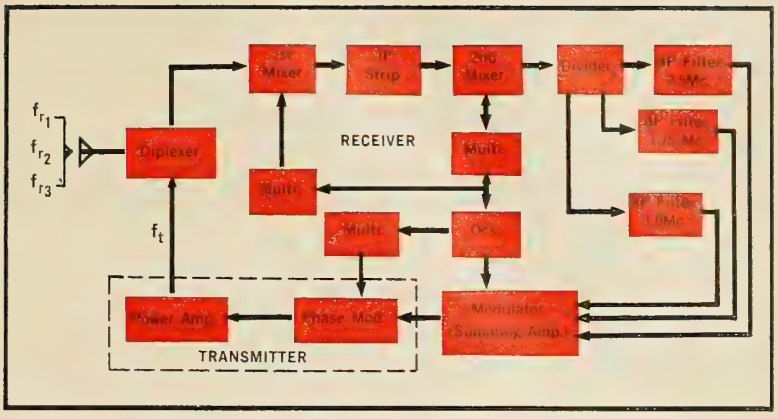
Today, however, there is an ever-increasing need for higher accuracies. For better control over manned and instrumented flights, for better understanding of the earth's gravitational field, and for expanding our knowledge of extraterrestrial influences, there is an urgent demand for the best obtainable data.

• **The Goddard system**—Studying the several tracking methods available, NASA scientists felt that the most easily instrumented would be one using Doppler and range techniques as a supplement to interferometer techniques.

Thus, range will be determined di-

# of Tracking

by Charles D. LaFond



Simplified Block Diagram of Satellite Transponder

rectly by measuring phase delay in the received signal; velocity will be measured directly by frequency change between the transmitted and received signal.

Essentially, the system as presently conceived will consist of three ground locations at appropriate points around the earth.

It is capable of three operating modes:

1. For missions requiring early orbit determinations, three stations having 300-500-mile base lines will be employed. Tracking will be simultaneous.

2. For highly eccentric orbits or lunar-distance probes, a 120° global spread will be used—to permit sequential but continuous tracking.

3. Single-station track can be used—particularly after establishment of initial orbital characteristics.

Each ground station will consist of two 30-ft. equipment vans, autotrack and antenna systems, power system, and individual timing system, teleprinter comunications, and communications antennas.

The antenna system will carry an antenna array for the 150/136-mc acquisition and/or ranging system and a 14-ft. paraboloidal-reflector antenna for the S-band range and range rate system.

The flight vehicle will carry a Minitrack beacon, the Motorola transponder, and associated electronics.

A major goal has been to make the tracking system as foolproof as possible, by simplifying both satellite-borne and ground equipment. Overall cost reduction has been secondary but important.

The Minitrack beacon will be used for initial vehicle acquisition. The ground array will be slaved to the R&RR dish. A shaft encoder coupled with the latter antenna will direct angle information to the recorder (see the system block diagram).

After vehicle lock-on, the R&RR transmitter will produce a reference carrier plus sideband pairs, obtained by frequency-modulating the carrier with several harmonically related sidetones.

Sidetones employed (from a 1-mc ultrastable oscillator) will be 100 kc, 20 kc, 4 kc, 800 cps, 160 cps, and 32 cps. The oscillator required must be accurate to 5 parts in 10^{10} day.

The lowest frequency produced will be divided further to provide both a range and Doppler reference of 8,4,2,1 cps. The reference pulses will be synchronized with WWV and initiate counting of 100 mc by a Time Interval Unit.

Using digital techniques, the highest-frequency (100 kc) phase delay to and from the satellite will be measured to an accuracy of 1% (15 meters). The lower frequencies can be used to resolve the ambiguity of how many whole cycle delays have occurred.

The transmitter carrier is to be used for performing the range rate measurement. It, too, will be derived from the same stable oscillator used to obtain the sidetones.

Specific frequencies have not yet been assigned; however, the transmitted signals from the ground stations will be in the S-band.

The satellite receiving subsystem of the transponder will be capable of handling transmissions from as many as three ground stations simultaneously. Frequency separation of about 1 mc is required.

So far, the particular flight-antenna type has not been determined. Under study now, the necessary antenna probably will be a directional type, but not necessarily high-gain.

Incoming signals will be amplified by the transponder, and each will be translated to a different part of the spectrum via mixers and band pass filters.

Total gain derived by the signals during processing will nearly equal the attenuation over the propagation path. Also, transponder design is such that its transmitter is always operating at full power even during acquisition.

After frequency translation the three signals are to be directed to a modulator, which serves as a summing amplifier, and mixed with the output of the offset oscillator. The summing process provides a strong, clean signal to the transmitter. Outputs from the transmitter to ground will be in the range of 1700-1710 mc. Carriers plus sidebands will be received in the range and range rate receivers.

Initial mixing with the transmitted reference carrier, and phase-locking of the receiver to the carrier, will result in a difference frequency which equals that of the transponder local oscillator, plus the total carrier Doppler shift, plus the Doppler shift of the transponder local oscillator frequency.

After signal processing in the receiver, the Doppler extraction and the separated sidetones can be directed through the R&RR analog/digital equipment.

Finally, digital outputs from the range and the Doppler time interval units will be multiplexed with the digital clock output and then punched on two separate teleprinter punch units.

Readout of time, range, range rate, and angular data will be produced at the rate of 1 reading/sec. or at a higher rate of 8/sec. Punched tapes will then be ready for relaying the data by standard teleprinter to the Goddard computing center.

System accuracy, the designers assert, will be limited only by resolution, unknowns of the propagating medium and our present knowledge of the velocity of light. ⁂

'Astrobee' Family Follows Aerobees

Space-General Corp.'s new line of unguided solid-fueled vehicles proposed for probe projects

by Richard van Osten

GLENDALE, CALIF.—A new family of high-altitude sounding rockets has been developed by Space-General Corp. as a follow-on to the successful but now 15-year-old *Aerobee* series.

Designated *"Astrobee,"* the new line was first used in geodetic experiments by the Air Force Cambridge Research Laboratory in late December with the launch of an *Astrobee-1500* from the Point Arguello, Calif., Naval Missile Facility.

The payload consisted of three flares to be released before, at, and during the vehicle's apogee. Special cameras at several stations photographed the flare bursts, and the resulting photo data is being analyzed in order to determine each camera site location with greater precision.

A more recent *Astrobee* shot was that of an *Astrobee-200* from Eglin AFB, Fla., in a vehicle performance test.

Currently, there are three basic vehicles in the *Astrobee* series: the *200, 250,* and *1500.* The number approximates the altitude in miles within the vehicle's basic capability with a nominal payload. But other than mission, there is little similarity between the *Astrobee* and its *Aerobee* predecessor.

• **The family**—All *Astrobees* are unguided, fixed-fin, rail-launched, two-stage solid-propellant rockets basically identical in concept and design. Again, the primary differences are in each vehicle's capabilities.

The *Astrobee-1500* has a payload range of from 50 to 300 lbs., and an altitude capability of over 1500 statute miles, depending upon mission requirements.

Overall length of the *1500* is 31.5 ft. First-stage length is 19.9 ft., and second-stage length is 10.6 ft. Payload section of the second stage is 4.9 ft. long, and has a capacity of 6.1 cu. ft. Diameter of the first stage is 31 in.—of the second stage, 20.5 in. The latter diameter remains constant through the payload section.

The first-stage propulsion unit actually has three solid-rocket motors. The primary motor is an *Aerojet Junior* (28KS-57,000) developing over 50,000 lbs. thrust. The motor case is fabricated by the "Aerowrap" process—a wrapped and bonded steel covered with a plastic. Forward and aft closures are 4130 steel. Nozzle housing is H. I. Thompson's "Refrasil" phenolic with a graphite throat. Propellant, an Aerojet proprietary development, is internal burning with a six-point star core.

Attached to the first-stage motor are two Thiokol *Recruits* (1.52KS-33,500).

ASTROBEE-1500 in launch position at Naval Missile Facility, Pt. Arguello.

In a launch operation, the *Junior* is ignited first. A motion sensing switch ignites the two *Recruits* 0.1 sec. later. The *Recruits* burn for 2.5 sec. Total first stage burn time is 40 sec., and a maximum velocity of Mach 6.0 is achieved at first-stage burnout.

Following burnout, there is an 8-sec. "coast" period. At the end of this time, three Atlantic Research Corp. spin motors (1.0KS-210) attached to the interstage area are ignited and the second stage is spun up to 10 revolutions per second.

At this point, the second stage is still within the nose fairings of the first stage. At T+49.5 sec., the nose fairings open 15° and, at T+50 the second stage is ignited.

Second stage for the *1500* is the Aerojet *Alcor* (30KS-8000) which is also used on *Blue Scout Jr.* and the *Astrobee-200.* The *Alcor* produces over 8000 lbs. of thrust for 30 sec., and has a mass ratio of 0.91. It was developed under an Air Force contract at Aerojet's Solid Rocket Plant, Sacramento, Calif., and is designed specifically for high performance in the 20-to-60-mile altitude range.

After first-stage burnout, vehicle weight is approximately 3500 lbs. The second-stage case and payload do not separate. A standard NASA separation diaphragm is used between first and second stage. No heat shielding or insulation is used on the second stage. To date, there is no requirement for it, and the additional weight could affect both payload capability and altitude performance.

• **Recovery possibility**—*Astrobees* normally are not designed for payload recovery. If the need arises, however, Space-General engineers say that although it would be necessary to develop a re-entry body, the basic *Aerobee* recovery system which was successful in over 50 recoveries could be adapted

rather easily. Design of a re-entry body poses some problems in that it might have some effect upon the payload package section.

The *Astrobee-200* is similar, although it uses a *Nike* booster as a first stage and the *Alcor* as a second. The *200* is 28-ft.-long with a diameter varying from 15 to 20 in., and is capable of boosting a payload of 165 lbs. to 182 statute miles.

Third of the present family, the *250*, is best described as the *1500* minus the second-stage motor. It has been designed to carry payloads ranging from 400 to 1300 lbs., and uses the entire second-stage section of the *1500* for payload area.

Development of the new series began in late 1960. First flight test of the *1500* was made in August, 1961, with something less than success. After slightly over 22 sec. of flight, the vehicle broke up in a violent maneuver. Examination of the debris brought the conclusion that the first-stage nozzle insert had burned through due to excessive erosion. The burn-through allowed exhaust gases to ignite the stabilizing fins, which also burned partially away, causing a loss of stabilization.

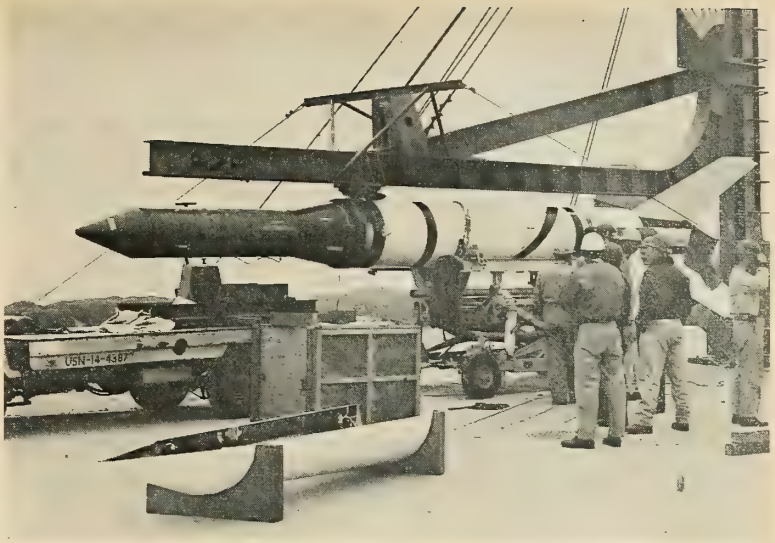
• **Problem solved**—The Solid Rocket Plant conducted a heat-transfer analysis of the 15° half angle nozzle—concluding that a refractory coating of zirconium oxide (Rokide Z) would correct the problem. Tests proved the analysis and solution to be correct.

Space-General is considering some additional changes which would simplify vehicle operational use. One is the possibility of reducing the spin rate down from 10 rps to about 2 rps. This, they believe, could make the vehicle more flexible in payload use. Some payloads for which the *Astrobee-1500* has been proposed, for example, are not and cannot be economically designed to take even the 10 rps spin rate loadings.

Some studies are under way to eliminate the spin motors completely, and additional flight tests will be conducted to determine if the "coast" period can be extended. There is also development work on an operational stage that would not be spun at all.

Other studies include the possibilities of using Aerowrap techniques for the second stage and 4130 steel for the entire first stage.

The *Astrobee* series has been proposed for several probe-type projects in the near future, and Space-General believes it has another off-the-shelf family with as long a future as the *Aerobees*. ⁂



PROJECT CAMBRIDGE payload being installed on the Astrobee-1500 at NMF, Pt. Arguello. Nose fairing for second stage is in handling cradle in foreground.

Design Dimensions—Nominal

ITEM		DIMENSION (inches)
Vehicle	Length	377.9
First Stage	Diameter	31.0
	Length	239.3
Second Stage	Diameter	20.5
	Length	127.2
Second Stage, Payload Section	Diameter	20.5 max.
	Length	58.77
First Stage Fins (4)	Airfoil shape	Single wedge with constant 8° section
	Semi-span	44.00
	Root chord	50.00
	Tip chord	31.40
	Sweep angle (leading edge)	45°
	Sweep angle (Trailing edge)	30°
	Adjustment—each side of 0.5° cant	.25°
	Aspect ratio	2.16
Second Stage skirt	Major diameter	28.03
	Area ratio	1.87
	Cone half angle	10°

Propulsion Ratings (Nominal)
For Astrobee 1500 Propulsion Subsystems and Spin Rockets

Parameter	1st-stage (Junior) 28 KS-57000 (50°F, sea level)	1st-stage (Recruit) 1.5 KS-35000 (60°F, sea level, one motor)	2nd-stage (Alcor) 30 KS-8000 (68°F, vacuum)	2nd-stage Spin Motor 1 KS-210 (70°F, vacuum)
Average thrust, pounds force	51,870	35,970	8,460	162
Total impulse, pounds force-sec	1,681,680	59,090	243,400	259
Average specific impulse, sec	227	220	279	254
Total burning time, sec	40.15	2.40	30.07	1.6
Average chamber pressure, psia	431.5	1,644	464	625
Thrust coefficient	1.596 (vacuum)	1.512	1.747	1.857
Nozzle expansion ratio	6.46:1	7.1:1	21.6:1 (average)	25.5:1
Nozzle exit area, sq ft	3.08	0.713	1.500 (average)	.0202

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W-C Parts Formed by

by John F. Judge

PARTS COMPOSED of tungsten and graphite in intimate contact are being formed in a unique hot-pressing process at Haynes Stellite Company, Division of Union Carbide Corp.

Experimental nozzles fabricated by the method have withstood exhaust temperatures upward of 6200° F with no apparent erosion.

The process consists of pressing tungsten powder into the desired shape using male and female graphite dies. The dies themselves become an integral part of the structure.

For example, in a nozzle configuration, the inside graphite is machined out together with a minimum amount of tungsten. The outside die remains a part of the piece and serves as a heat sink.

Boundary layers of stable oxides and carbides have been used to avoid low-melting eutectic formation with the accompanying hot-spot generation. Test firings have shown that this may not be necessary.

• **Cuts machining**—The process eliminates a great deal of the tungsten machining normally associated with such configurations. Haynes Stellite metallurgists see no inherent limitations in the process with regard to scale-up. A 50-ton hydraulic press is currently being used in the experimental program. A 2000-ton press is available and has been used successfully on a limited production basis.

DIE-WORKPIECE CUTAWAY illustrates Haynes Stellite approach to hot-pressing tungsten bodies intimately with graphite.

Parts are formed at elevated temperatures. The apparatus is set up in a standard hydraulic press, and induction coils form the heating elements.

Ram travel is predetermined by the desired density, and force depends on the configuration. The die-workpiece combination is maintained in an inert atmosphere. Pressure and temperature rises are incremental, and there is a final hold-time at maximum temperatures.

Haynes Stellite metallurgists can control the density of the tungsten com-

LEFT: *Tungsten-graphite nozzle takes shape after the machining operation. The graphite section normally remains as part of the finished piece.*

RIGHT: *Process was developed on this small hydraulic press. Induction heating apparatus is visible in the press work area.*

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Hot Pressing

ponent. This is determined by the end application of the part. Current densities range between 91 and 95%.

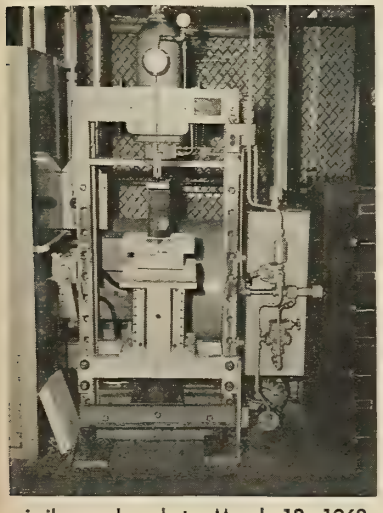
Compacting of the tungsten powder can be increased with surface activators. This consists of mixing with the tungsten powdered metals such as nickel, in amounts small enough to have no effect on the strength of the tungsten. The firm's specialists say there are a number of methods for improving the properties of hot-pressed tungsten.

Haynes Stellite has been active in the hot-pressing area since 1948. The first applications of hot pressing were in armor-piercing shells. Thus far, the largest hot-pressed pieces fabricated on its production equipment have been 16.5 in. in diameter.

The Division's idea of using a composite, intimately bonded, tungsten-graphite nozzle—obtainable by suitable graphite die design for the hot-pressing operation—was further developed through a project sponsored by Aerojet-General Corp.

After trying various alloying approaches, Haynes Stellite hit on the idea of graphite dies. The most difficult part of the process is the die design. The correct density of the tungsten nozzle liner is achieved through die engineering.

Division experts say geometries other than simple cylinders and nozzles are conceivable, but care must be taken in choosing the suitable configuration. ❖



MISSILE - SPACE

ENGINEERS and SCIENTISTS

The Aircraft-Missiles Division needs exceptional talent to spearhead accelerated growth into selected, key aerospace areas such as satellite and reentry systems, reconnaissance-surveillance systems, communications and power for space applications, and advanced missile systems.

ADVANCED SYSTEMS ENGINEERING

Manpower Requirements—College graduates with 4-10 years increasingly more responsible experience in depth in space, reentry vehicle and satellite programs in control systems, guidance systems, sensor systems, communications systems, propulsion systems, data systems, computers (airborne), vehicle systems (reentry and space), recovery systems, command systems.

SYSTEMS ENGINEERING

Manpower Requirements—College graduates with 5-10 years increasingly responsible experience in depth the last several years of which must have been in systems engineering in one or more of the following areas—control systems, guidance systems, sensor systems, communications systems, propulsion systems, data systems, computers (airborne), vehicle systems (reentry and space), recovery systems, command systems.

ELECTRONICS ENGINEERING

Manpower Requirements—College graduates with 4-10 years progressively more responsible experience in depth preferably as related to ballistic missiles, space and reentry vehicles, satellites and associated systems in such areas as data systems, radar, telemetry, tracking equipment, sensor equipment, guidance (command and inertial), control, computers, ground support equipment.

ENGINEERING TECHNOLOGIES

Manpower Requirements—College graduates with 3-10 years of increasingly more responsible experience demonstrating ability to handle problems in one or more of the following areas—heat transfer-fluid flow, orbital mechanics, trajectory analysis, aerophysics, magneto hydrodynamics, applied mechanics, aerothermodynamics, space dynamics, numerical analysis, calculus of variations, statistics and information theory.

DESIGN ENGINEERING

Manpower Requirements—College graduates with 5-10 years of progressively more responsible and complex subsystem design experience and demonstrated excellence of capacity in handling such assignments in one or more of the following areas—propulsion, servomechanisms, vehicle structures, space power systems, electrical power and distribution, recovery systems, ground support equipment and environmental control.

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Radar/Beacon Proposed for Rendezvous

Modified version of Army field radar developed by Cutler-Hammer would have total weight of 35 lbs.

by Michael Getler

MELVILLE, L.I., N.Y. — A lightweight and low-power radar, originally developed for Army field combat surveillance use, is now being proposed for spacecraft orbital rendezvous and docking missions.

The basic rendezvous system consists of a 30-lb. Ku-band pulsed acquisition and track radar—a modified version of an Army field radar now in service test; and a 5-lb. omni-directional beacon—also using repackaged Army radar components.

Both the Army system and the modified spacecraft version were developed here by the Airborne Instruments Laboratory division of Cutler-Hammer, Inc.

A team of engineers from AIL recently presented technical details on the spacecraft system to North American Aviation, prime contractor for NASA's *Apollo* manned lunar project. The company is also expected to propose the system to the firm which wins the still-to-be-announced *Apollo* lunar landing module competition. Other projects being eyed by AIL for this system include the Air Force *Dyna-Soar* and *Saint* programs.

In the AIL system, the rendezvous radar installed in a "pursuit" vehicle is reportedly capable of acquiring and tracking the beacon signals from a second spacecraft in a "parked" orbit at ranges up to 1000 miles, and supplying continuous range, range-rate, angle, and angular-rate outputs to a pilot display or automatic system throughout the orbital transfer maneuver.

• **Possible mission profile**—Though very little is firm concerning how the particular transfer maneuver will be made, AIL in its informal proposal assumes that the pursuit vehicle, carrying the main radar, will be in a 100-mile-high earth orbit, with the parked spacecraft in a 300-mile-high path. Actual acquisition range in this situation would probably be on the order of 600 miles.

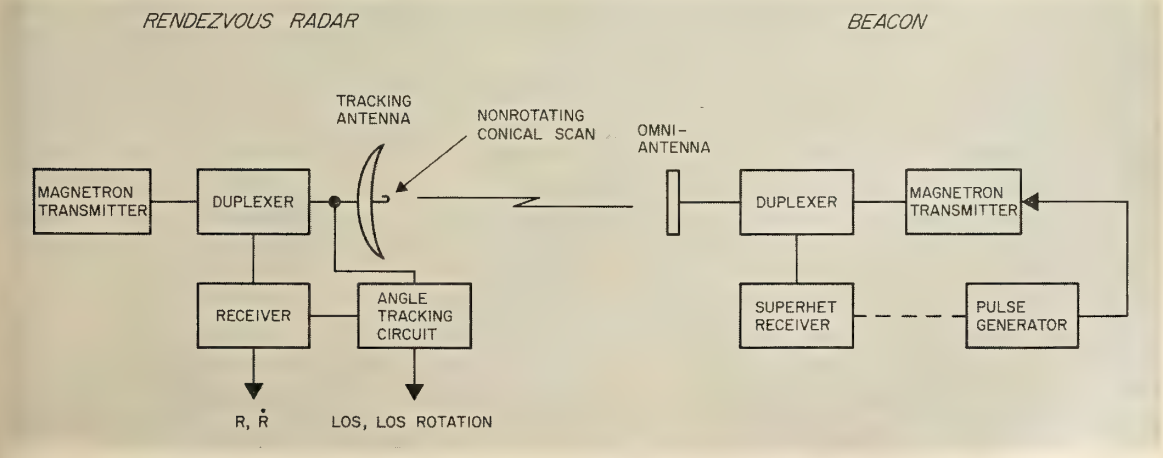
The rendezvous radar, once locked on the beacon signals, would reportedly continue supplying data to a point roughly between 1 and 4 miles in front of the parked vehicle, with the joining spacecraft closing at initial velocities of between 5 and 10 fps.

At this point, the docking instrumentation is activated—supplying final range, range-rate, and three-axis tilt and rotational information by CW doppler and phase measurement techniques until actual contact is made between the two craft.

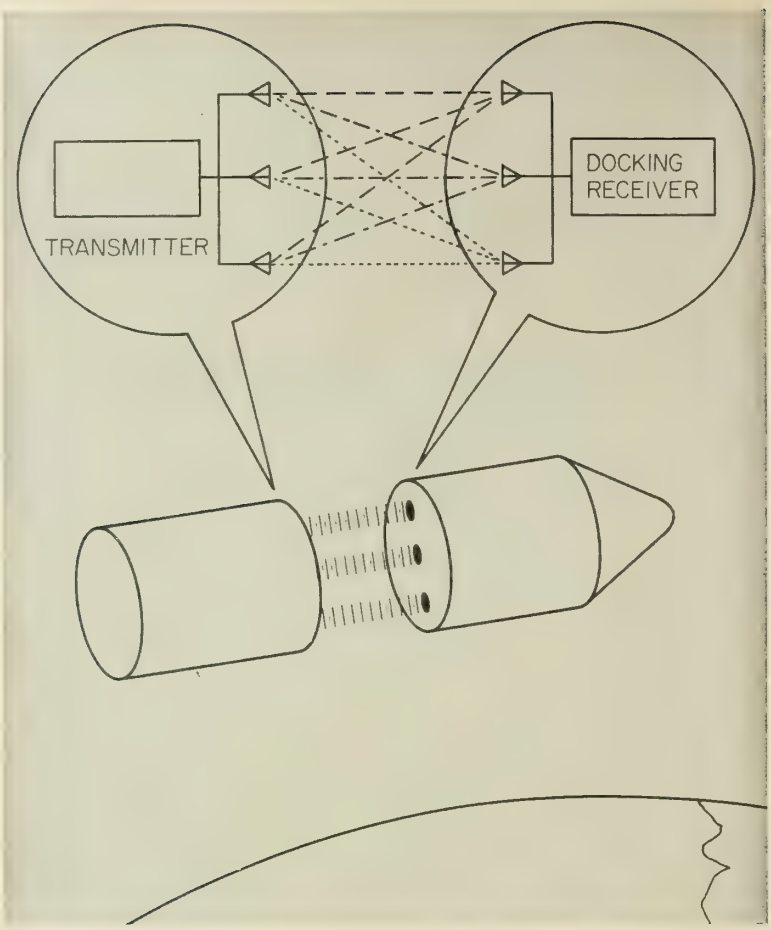
Total equipment weight of the three systems required for the final docking maneuver is 20 lbs. in the pursuit vehicle and 9 lbs. in the parked craft.

The rendezvous radar is also intended to supply altitude information during launch and earth orbit, and, if located in the lunar landing capsule, also during actual descent to the lunar surface. The system's altitude measurement capabilities are reportedly accurate to within 100 ft. of the surface.

The rendezvous of the lunar landing module with the parent ship parked in a lunar orbit—probably at a lower altitude than an earth orbit—would be basically the same as that used to get



BLOCK DIAGRAM SHOWS basic cooperative rendezvous radar system being proposed by AIL.



TILT AND ROTATION docking alignment. Fourth (redundant) channel is not shown.

the mission under way from earth. AIL engineers point out that with the rendezvous radar located in the landing device, the system could supply accurate track and orbital path data on the orbiting craft prior to take-off from the moon.

• **Hardware available**—Through the use of relatively simple and well established techniques and the employment of considerable existing hardware, AIL engineers feel their system—in terms of weight, size, and power demands—represents the most economical way to go about providing radar-derived rendezvous and docking information.

Selection of Ku-band reportedly was prompted by extensive company experience working in this frequency range, availability of Ku-band components, and by the large reduction in antenna size over X-band for the same bandwidth and antenna gain. The Ku-band, according to AIL officials, is also better suited for high-altitude altimeter usage.

The 36-in. parabolic antenna and much of the associated drive equipment used in the rendezvous radar is the same as that employed in the Army equipment. This portion of the system currently represents about two-thirds of the total 30-lb. package. To reduce system weight even further and also lessen the number of moving parts, AIL is at work developing a non-scan antenna for use with this system.

• **35 watts tops**—Maximum power consumption for the radar is 35 watts, demanded during high prf operation. A non-mechanical conical scan arrangement is employed for angle tracking in order to further simplify and cut system weight. Range tracking is accomplished by the leading-edge method. The reflector gain is designed for better than 40-db, with a 3-db, 1.5-deg beamwidth. Circular polarization is also employed in the rendezvous radar.

A list of radar performance parameters shows range and range-rate accuracies within 1%, at ranges between 100 ft. and 600 miles, and at rates between 1 ft./sec. and 600 ft./sec. The system's angular rate capabilities, which are designed up to 114-deg/sec., are reportedly accurate to within ± 1 mil/sec. Overall angular accuracy is ± 1 mil.

The 5-lb. beacon transponder employs a simple prf code and shifting technique, with two linearly polarized 1-oz. beacon antennas to supply nearly omnidirectional coverage. Maximum power demand on the beacon equipment during high prf operation is 15 watts. The transponder will also have a built-in 2 microsecond time delay to permit pulsed operation at close range.

Estimated operating life for the beacon has been set at 10,000 hours, with 7500 hours for the main radar. Testing is still going on in this area.

• **Docking systems**—In order to accomplish the short range measurements required in the docking procedure, a variety of low-power (100 mw) narrow beamwidth CW techniques are used in conjunction with circularly polarized, small-aperture antennas.

Range data from 0 to 4 miles during docking is obtained to within ± 1 meter accuracies through use of phase comparison techniques. An L-band operation is used with active T/R systems in each vehicle to cope with low-power signal feedthrough problems.

The range-rate information system requirements call for velocity measurements between 0.1 and 10 fps, accurate to within 0.1 fps. This system utilizes a straight CW narrow-band Doppler resolution method operating at X-band. To maintain the necessary antenna gain to operate at a 100 mw level, the range-rate system employs the rendezvous radar antenna and a corner reflector attached to the second vehicle. At about ¼ mile, the system switches from the main dish to a small 2-sq.-in. omnidirectional antenna.

Up-down, left-right tilt through ± 90-deg, and rotation about the longitudinal axis through 360-deg, will be measured to within 1-deg accuracy by an L-band system which is offset from the L-band range data frequencies.

The operation of this system relies on measurements of differential distances between a point source transmitter and a set of receiving antennas located in one plane but not along one straight line. Three sets of differential path measurements are required to establish the angle between the plane of the transmitting antennas and the plane of the receiving antennas, as well as their angular orientation.

Eight 15-cm (4-oz.) omnidirectional antennas, four on each vehicle, are employed in this phase of the docking maneuver, with four transmission channels designed to improve reliability and provide some system redundancy.

With respect to spatial environment problems, AIL engineers feel that suitable internal lubricants and external antenna coatings are available to provide unimpeded operation for at least several days. ⌗

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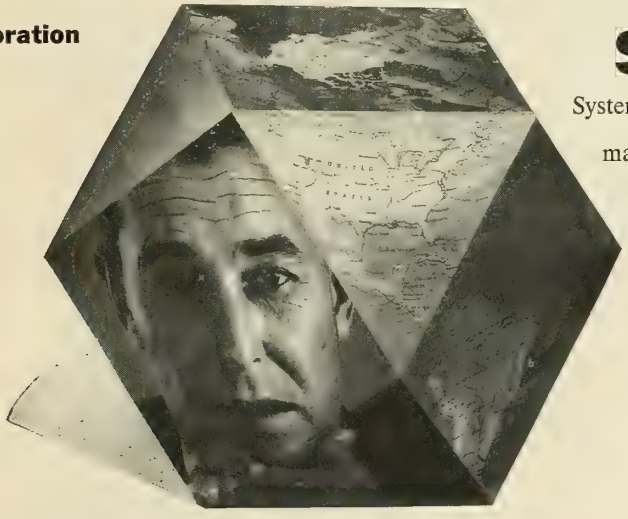

DECISION-MAKING ON A GLOBAL SCALE

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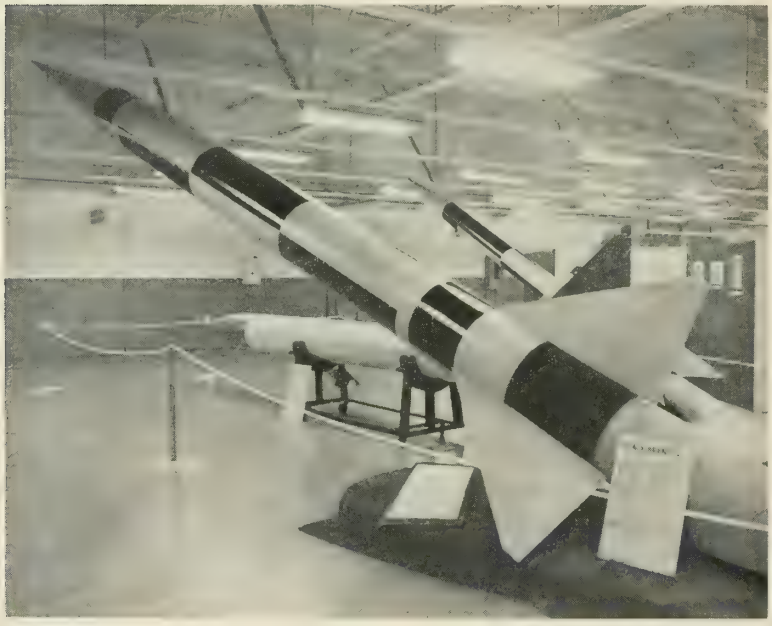
Canada Expands Black Brant Series

Built by Bristol Aero-Industries, three new rockets will offer varied capabilities for high-altitude research

by Bernard Poirier



BLACK BRANT V will be able to haul payloads as heavy as 300 lbs. Single-stage, 28.4-ft.-long vehicle can take a lighter load 240 mi. up in 240 seconds.

Black Brant Series

	I	II	III	IVA	V
Overall length	24.3 ft.	27.7 ft.	18.2 ft.	35.8 ft.	28.4 ft.
Nose cone length	5.2 ft.	7.2 ft.	3.9 ft.	3.9 ft.	6.6 ft.
Total weight	2492.8 lbs.	2782.3 lbs.	643.0 lbs.	3104.0 lbs.	2639.0 lbs.
Payload area cu. ft.	4.0	6.2	1.3	1.3	8.4
Maximum payload	150.0 lbs.	150.0 lbs.	75.0 lbs.	75.0 lbs.	300.0 lbs.
Max. Alt. for max. p/l	140 mi.	170 mi.	100 mi.	530 mi.	190 mi.
FIRST STAGE					
Weight	1759 lbs.	2095 lbs.	583 lbs.	2300 lbs.	2427 lbs.
Thrust	20,000 lbs.	16,000 lbs.	11,400 lbs.	24,500 lbs.	20,000 lbs.
Tot. imp. sec. lb.	400,000	420,000	102,100	383,200	452,000
Burning time	20 secs.	26 secs.	9 secs.	15 secs.	23 secs.
SECOND STAGE					
Weight	none	none	none	594 lbs.	none
Thrust	none	none	none	12,650 lbs.	none
Tot. imp. sec. lb.	none	none	none	113,700	none
Burning time	none	none	none	9 secs.	none

A JOINT EFFORT by Canadian industry and government is soon to bear fruit in a new group of high-altitude research rockets that may prove highly attractive to nations with limited space budgets.

The new rockets are additions to the *Black Brant* series: *Black Brant III*, *Black Brant IVA*, and *Black Brant V*. *Black Brant III* is nearing flight-testing at Fort Churchill Rocket Range on the Manitoba side of Hudson Bay.

Bristol Aero-Industries Limited, Winnipeg Division, is prime contractor for all three vehicles.

Earlier development of the *Black Brant* series, particularly in propellants, was spearheaded by the Canadian Armament Research and Development Establishment (CARDE) at Valcartier, Quebec. CARDE, operating under the Defense Research Board, will continue propellant development in the expanded program.

Bristol Aero-Industries performed design studies on advanced sounding rockets as a private venture for several years. The firm finally was awarded a design and development contract last year by the Defense Research Board and the Department of Defense Production.

Canadian scientists of the Defense Research Council also will participate in the government/industry effort. Both groups participated in earlier Fort Churchill experiments as well as Canada's *Alouette* satellite projects (M/R, May 8, 1961, p. 44).

• **Varied abilities**—*Black Brant III* is designed to carry at least three different payloads: 25, 40 and 75 lbs. In each case, instrumentation will undergo considerable stress—accelerations are rated as high as 31 g's for the lightest payloads. Given an 85° launch, 100-mile peak altitudes will be reached in 190 sec., and 130 miles in 210 sec.

Propellant temperature range is −20°F to +120°F for each rocket motor in the new development series. Concomitant to the *Black Brant III* program is the second-stage capability for *Black Brant IVA,* whose first stage appears to be a later effort paralleling the single-stage *Black Brant V.*

The two-stage *Black Brant IVA* will carry a 75-lb. scientific payload to 530 miles, almost twice the altitude foreseen in *Black Brant V* design specifications. High Arctic soundings will be performed by this two-stage carrier: 25 lbs. to 630 miles, 40 lbs. to 590 miles and 75 lbs. to 530 miles.

The two-stage Bristol Aero-Industries rocket will undergo maximum accelerations of 37 to 44 g's. In experiments which require 40 lbs. of instrumentation, burnout will occur at 113,000 ft., yet its maximum 42-g acceleration and 13,230 ft. sec. velocity will carry the payload to a 3,100,000-ft. apogee. (Similar performance requirements have been suggested for European tests at Kiruna, Sweden.)

The 28.4-ft. *Black Brant V* design offers a true scientific workhorse for heavy payloads, up to 300 lbs., with no multistage problems to complicate flight-test operations. Moreover, the maximum g load is low (18 g's for a 150-lb. payload), taking 240 sec. to reach 240 miles altitude.

Bristol Aero-Industries plans two types of *Black Brant IV* rockets. A company spokesman said; "Actually the designation *IVA* refers to the vehicle utilizing the *Black Brant III* and *Black Brant II* motors. It is intended that a designation *IVB* will be used to identify the *Black Brant IV* using *III* and *V* motors." ⌘

BLACK BRANT III will soon be tested in flight at Canada's Ft. Churchill range.

French Move to Meet 5000-a-Year Launch Program

Built by Bristol Aero-Industries, three new rockets will offer varied capabilities for high-altitude research

TO FULFILL A sounding rocket program that eventually will call for 5000 launchings per year, France is intent on developing a family of reliable solid-fuel rocket motors.

The *Mammouth* and *Stromboli* motors are the latest to be authorized. Overall development responsibility rests with Sud Aviation's Technical Group at Cannes and France's IRBM agency S.E.R.E.B.

Sud already is developing another series which includes flight-tested *Bélier* and *Centaure,* to be followed by *Dragon* and a three-stage *Pégase.* France's NASA equivalent — O.N.E.R.A. — has two four-stage vehicles in development —*Antarès* and *Bérénice,* the first-named of which has undergone regular flight tests at the French Navy's Mediterranean rocket test site on Levant Island.

When the 5280-lb. *Mammouth I* motor is coupled to an instrumentation payload, it is identified as the 7040-lb. *Agate* sounding rocket which had two successful tests as early as last June (M/R, Aug. 7, 1961, p. 48).

Agate will evolve into a second vehicle using a *Stromboli* second stage and, finally, into a 14,300-lb. (with payload) configuration utilizing two *Mammouth* stages and a *Stromboli* third stage.

Agate has no guidance; aerodynamic stability in acceleration is provided by four basic fins near the booster rear. So far, the only guidance suggested in French experiments remains restricted to the O.N.E.R.A. *Antarès* first stage.

The outer wall of the *Agate* instrumentation cone is fabricated of an asbestos-glass-resin combination. Instrumentation and recovery apparatus accounts for about 70% of the total payload, not including what appears to be an additional 800 lbs. for the motor casing and nozzle weight.

Although it had been suggested in symposia earlier this year that two separate instrumentation packages are recovered from *Agate,* it now appears that only one recovery mode is actually programed for this test vehicle—and that it is a highly reliable function.

Agate's performance parameters provide selection between a 1080-lb. payload to 38 miles and 110 lbs. to 90 miles. A *Stromboli* second stage increases optimum selection to 265 lbs. to 285 miles; two *Mammouth* stages plus a *Stromboli* third stage, 265 lbs. to 950 miles.

Standard instrumentation during the first six months of *Agate* testing has included 6-channel, 15-watt telemetering transmitters (TURKS-SAT FM/AM). Frequencies used are between 40 and 185 mc/s. These plus two magnetic recorders constitute the basic load. Other useable space is available for whatever optional equipment is required for the flight experiment involved.

During the coming year, SECOR responders and other radar equipment will be installed. In the meantime, flares are carried in the skirt of the instrumentation cone to facilitate optical tracking.

This will be an important year for utilizing the first fruits of French solid rocket development. The smallest variety will be used for about 15 daily firings—two or three from each of five or six locations in metropolitan France. These will be meteorological experiments carrying small 10-lb. payloads.

However, heavier payloads and larger rockets will be needed for scientific experiments using 65-lb. payloads, and for "advanced" scientific experiments using 250 lbs. The French plan to sound with these payloads at 50, 100, 250, 625 and 1200 miles altitude.

Solid-fuel motors apparently have A-1 priority "The fundamental parameter is reliability," French scientists say, "and success of future programs cannot be subjected to unknown whims of untried rockets. ⌘

Key Contracts

(Continued from page 15)

of power continuously for a 90-day mission of *Surveyor*, which is designed to soft-land on the moon.

Fuel for *SNAP 11* will be Curium-242, a man-made element. As the Curium decays spontaneously it produces heat which will be converted directly into electricity by the thermoelectric generator. The only moving part in the generator will be a temperature-controlled shutter which will control the flow of heat to keep power output relatively constant.

Martin said that during the two-week periods when the moon landing site will be in total darkness, the temperature of the surface dips to −235°F.

This temperature, Martin said, will step up the output of *SNAP 11* to 25 watts. During this period, excess heat from the generator will be used to keep sensitive electronic components in the system within a reasonable temperature range.

• **Nuclear simulator**—In a related nuclear power development, NASA announced that a 300-kilowatt liquid-metal boiling and condensing test facility has been placed in operation.

The new facility—the largest in the U.S.—was designed by GE under a NASA contract. It will be used to study heat transfer characteristics of several liquid-metal working fluids.

Development of a nuclear turbogenerator systems that will produce 300 kilowatts or more of electrical power has been in progress at General Electric for more than four years. These space power systems are designed to use heat energy generated by a nuclear reactor to vaporize liquid alkali metals, like potassium or sodium. The vapor then powers a turbine which drives an electrical generator.

The new 300-kilowatt test facility will permit the behavior of liquid metals to be investigated under the conditions of boiling and condensing they will encounter in actual operation in space power systems. The facility can operate continuously at temperatures up to 1850°F. Because the liquid metals used are highly corrosive, the facility is constructed entirely of a tough cobalt-base alloy.

Essentially, the facility consists of a large gas-fired heater, which simulates the reactor heat source, and two separate closed loops through which the liquid metals are pumped in a continuous cycle. The primary loop carries heat to a boiler test section, which transfers its heat to a secondary loop in which another liquid metal is vaporized. The secondary loop also contains condenser test sections which remove the heat from the system by radiation or convection.

With this facility, many characteristics of a large nuclear turbogenerator system can be effectively simulated. Different working fluids can be tested in the two loops simultaneously, since they are completely separate. The primary loop can handle flow rates greater than 200 gallons per minute with a pressure rise of 20 psi. The secondary loop can operate at 30 gpm with a pressure rise of 30 psi when the alkali metal is in a liquid state, or at 3.5 gpm with a pressure rise of 100 psi when the metal is vaporized. The entire facility is operated and monitored from an adjacent control and data recording center.

This latest facility is one of several planned in support of NASA's long-range programs for development of space power supplies up to 1000 kilowatts and larger. Other facilities in various stages of design or construction at GE's Space Projects Laboratory include a liquid-metal boiling and condensing heat-transfer test facility which will operate at temperatures up to 2200°F; a facility to test the operation of bearings in liquid metals; and a facility for testing full-scale high-speed turbines, boilers, condensers and radiators. ⁂

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Haley sees 'problem' . . .

Details of IAS-ARS Merger Disclosed

WORK GROUPS from the Institute of the Aerospace Sciences and the American Rocket Society took time off during a recent IAS symposium in San Francisco to hammer out the constitution and bylaws for a proposed merged society which would be called the "American Institute of Aeronautics and Astronautics, Inc."

L. Eugene Root and Dr. William H. Pickering, IAS and ARS presidents respectively, endorsed the consolidation. They said they expected to speak in favor of the proposition at about 50 technical meetings before June, when members of the two organizations will vote on the issue.

In discussing prospects for the new organization, Pickering said there "would not be fewer meetings, but I hope (we) will have better coordinated meetings suited to the combined interests of the society." He added that he had detected an "overwhelming response" in favor of consolidation.

Declaring that he would follow Dr. Pickering's endorsement, Andrew G. Haley, ARS general counsel, warned in Washington, D.C., that the merger might not be easily effected, however strong the support for it. He explained that a consolidation can be made only if it is approved by a majority of all members eligible to vote in each society. This means that a small return of ballots would kill the merger. "It is going to cause quite a problem," Haley said.

A first-draft constitution describes the "Institute" as "organized as a nonprofit scientific and engineering membership society to advance the arts, sciences and technology of aeronautics and astronautics."

These objectives will be accomplished by "encouraging original research and the dissemination of new knowledge, furthering the professional development of those engaged in scientific and engineering disciplines, fostering engineering education, promoting continual interchange among engineers and scientists and with other professional groups, stimulating outstanding professional accomplishments, and such other means as may be appropriate to meet the professional needs of its members."

• **Membership**—The Institute will have nine grades of members, according to a near-final draft of its bylaws: Honorary Fellows, Benefactors, Fellow Members, Senior Members, Members, Associate Members, Student Members, and Corporate Members.

Honorary Fellows are described as "persons of eminence in aeronautics and astronautics"; Honorary Members, "distinguished citizens who have shown notable support for the ideals and objectives of the Institute"; and Benefactors, "persons . . . who have contributed not less than $10,000 to the Society." (Note the vestigial use of "Society.")

Fellow Members are to be those who have made important technical contributions to aeronautics or astronautics and "attained national distinction in their fields"; Senior Members, those who have 12 years' experience and "who have by superior performance in at least four of those years attained recognition in their fields"; and Members, "professional persons with at least eight years' experience . . . who have demonstrated competence in their field."

Associate Members are to have a professional activity or interest in aeronautics or astronautics; Student Members are to be undergraduates or graduates under the age of 28 attending school full-time; and Corporate Members are to comprise educational, scientific, and industrial organizations interested in aeronautics or astronautics.

• **Dues**—The dues are pegged at $20 a year, payable in advance, for Honorary Fellows, Fellow Members, Senior Members, Members and Associate Members. Student Members will pay five dollars a year.

There will be no dues for Honorary Members or Benefactors. A single lump-sum payment will give any dues-paying member a lifetime membership. Depending on the member's age, the amount varies from $600 for the 25-30-year-old bracket, to a minimum of $205 for those 61 years old and over.

• **Meetings**—Annual meetings are to be held each year on the first Tuesday of November at New York City, or at any other time and place the Board of Directors decides.

At these meetings, "The Secretary shall cause ballots for the elections of President, Vice Presidents, and Directors . . . and for voting upon such propositions as shall be submitted to any meeting of the Institute."

Special meetings may be called by three Directors, or by the President upon petition of at least 100 members holding voting privileges.

• **Board of Directors**—The Institute's governing body will be a Board of Directors comprising the President and four Vice Presidents—the ex-officio directors—and 18 elected Directors.

The Assistant to the President, General Counsel, Executive Secretary, Treasurer, Secretary, Controller and Director of Publications—if none are elected Directors—will be entitled to participate in all Board meetings, but will not vote. Six new directors will be elected at each annual meeting for a three-year term, but no Director will be eligible to serve more than two consecutive terms. The President will normally act as Chairman of the Board.

• **Officers**—"The officers of the Institute will consist of a President, four Vice Presidents, a Secretary, a Controller, a General Counsel, a Treasurer, and such other officers as from time to time shall be appointed by the Board. Term of office will be one year, except for the Executive Secretary, Assistant to the President, Treasurer, Secretary, Controller, and General Counsel.

"The officers, with the exception of the President and Vice Presidents, shall receive such salaries as may be fixed by the Board of Directors."

• **Committees**—There will be the following committees in addition to Standing Committees: Nominating, Executive, Policy, Membership, Awards, Finance, Program, Section Activities, Long-Range Planning, International Affairs, and Education.

The Nominating Committee "shall ask for nominees from the immediate past Presidents of all Institute Sections, and the Chairman of all Technical Committees. The candidates for the positions of President, Vice President and Director shall be selected by the Committee from these nominees only." However, additional nominees can be put on the ballot by petition of 100 or more voting members.

The Executive Committee will exercise certain limited functions of the Board of Directors.

The missions of the other committees fall in line with their titles. The President will be an ex-officio member of all committees except the Nominating Committee. ⁂

(See editorial, p. 46)

The Industry Week

Industry Trends and Reviews

Lockheed Missiles & Space Co. last year used 1732 new vendors for products and services. Of these, 1607 were small businesses. . . . *Aircraft and missiles will lead the reinforced plastics market in 1962 with projected total sales of $95.8 million—20% of the total in filament-wound plastic products—estimates the Reinforced Plastics Div. of the Society of the Plastics Industry Inc. Sales for aircraft and missiles will be nearly double those for the next leading market, boats.* . . . President of the Linde Co., Div. of Union Carbide, says the continuing growth of cryogenic products and industrial gases carried the industry's total domestic sales to a new high last year. . . . *Aero Geo Astro Corp., Alexandria, Va. began an annual scholarship program designed to encourage area high school students to pursue space science careers.* . . . An Aerospace Industries Association spokesman said that under today's depreciation policy, about one-third of all U.S. plants and equipment are obsolete by European standards. He said the burden of inadequate depreciation allowances is the principal factor in the steady decline of U.S. industry in the Free World marketplace in the past 15 years. . . . *A sharp, unexpected rise in demand for engineers and scientists during the first months of the year was reported by the Engineer/Scientist Demand Index of Deutsch & Shea, Inc., technical manpower consultants.*

News of Mergers and Expansions

Microdot Inc. and Varec, Inc., have merged, with Varec operating as a wholly-owned subsidiary. Microdot manufactures aerospace electronic components, and Varec industrial control devices and telemetry systems. . . . *General Time Corp. completed arrangements to acquire Barth Engineering and Manufacturing Co., Meriden, Conn., makers of meteorological weather sounding receptors, servomechanisms and related equipment.*... G-V Controls Inc., Livingston, N.J., purchased Uni-Seal, Inc., Garwood, N.J. Uni-Seal, maker of hermetic glass-to-metal seals, plans a major expansion of facilities and output for this year. . . . *Zero Manufacturing Co. purchased a plant in Monson, Mass., comprising 15 acres of land and 150,000 sq. ft. of manufacturing area. The facility will nearly double Zero's Eastern capacity, and will be occupied by April 1.* . . . Interstate Engineering Corp. acquired National Marine Consultants, Inc. NMC will operate as a division of Interstate Electronics Corp., subsidiary of IE and prime contractor for test instrumentation in the Navy Fleet Ballistic Missile Weapon Systems program. . . . *Rocketdyne Div. of North American Aviation will build an advanced metals forming facility near El Toro, Calif. The $250,000 plant will be used for high-energy forming of metal components for space and commercial applications.* . . . The Bendix Corp's Cincinnati Div. will build a new plant to consolidate operations. Occupancy is planned for the end of this year. . . . *Computer Equipment Corp., Los Angeles, has doubled the capacity of its Cableaire Div., developers and manufacturers of electronic cable assemblies and harnesses used in aircraft, missiles and GSE.* . . . Tempo Instrument Inc. formed a Systems Division to provide engineering and manufacturing facilities for a new line of commercial and industrial products. . . . *Branson Corp. purchased land in Denville, N.J., to triple manufacturing and engineering facilities for manufacture of magnetic and time delay relays for aircraft, missiles and GSE.* . . . American Machine and Foundry's Government Products Group opened a new Environmental Laboratory at Stamford, Conn., to analyze environmental effects on components for aerospace GSE, missile and aircraft operations. . . . *Holex, Inc., Hollister, Calif., is beginning a major expansion program. The firm, a supplier of explosive cartridges and explosively-actuated devices for the missile/space industry, will soon begin construction of two new buildings. Five more are planned.* . . . Microdot Inc. established a Hermetic Seal Facility at South Pasadena, Calif., for production of microminiature glass and ceramic seals.

New Names in the Industry

Trodyne Corp. has been formed in Teterboro, N.J., to develop and manufacture components and systems for use in aircraft, submarines and missiles. Principal products will be flight simulator systems and components, visual aid systems and training devices, GSE and related equipment. . . . *SKG Corp., Santa Ana, Calif., was organized to undertake feasibility studies, systems development, management, production and marketing of proprietary products in areas of automatic monitoring and control, telemetering and medical electronics. President Verl O. Smith, Jr., is former assistant to the vice president in charge of engineering of Northrop Corp. and was chief of the Missile Test Facility at Cape Canaveral.* . . . Decision Systems, Inc., was formed in Silver Spring, Md., to apply advanced electronic information processing techniques to management and control problems of government agencies and industry.

International News Briefs

North American Aviation, Inc., formed a subsidiary in Torino, Italy, for maintenance of fire control units sold by the company's Autonetics Div. for the European F-104 Starfighters. . . . *Elgeet Optical Co., Inc., agreed to acquire the Steinheil Co., Munich, West Germany, one of the largest optical manufacturers in Europe.* . . . Beckman Instruments, Inc., formed a jointly-owned company with Tokyo Shibaura Electric Co. (Toshiba) to manufacture and distribute Beckman products in Japan. Beckman-Toshiba, Ltd. Tokyo, will begin immediate production of precision potentiometers and gas chromatographs for scientific and industrial application. . . . *Dornier of West Germany is planning to design satellites as part of the West German contribution to the European Space Research Program. The company said its research labs are working on designs for unmanned research capsules similar to those of the U.S. Discoverer series.*

ENGINEERS & SCIENTISTS

in the fields of space vehicle power and propulsion

The Propulsion and Power Systems Department of the Aerospace Vehicles Laboratory has several unusually interesting openings for engineers and scientists who are interested in the fields of space vehicle power and propulsion. The openings are at all levels of experience—from recent graduates to the senior staff level. Most of the positions will involve design and analysis of power and propulsion systems for satellite and space probe application. Specifically, some of the areas of specialization are:

1 SPACE POWER SYSTEMS
The positions will involve analysis and development of such energy sources as: photo voltaic, thermionic, thermoelectric, battery and advanced energy storage systems.

2 SPACE PROPULSION SYSTEMS
The positions will involve the preliminary and conceptual design and comparative analysis of all types of chemical and electric propulsion systems.

3 PROGRAM MANAGEMENT
The positions will be associated with the development of solid and liquid propellent rocket engines. Advanced degrees are preferred and considerable experience in the field will be required.

If you are interested and believe that you can contribute, please mail your resume to:

Robert A. Martin,
Supervisor of Employment
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AEROSPACE DIVISIONS

contracts

AIR FORCE

$23,500,000—**General Dynamics Corp.**, San Diego, Calif., for installation and checkout of *Atlas F* missiles, for provision of spare parts for the *Atlas* program and for operation and test of a systems test facility at Vandenberg AFB (3 contracts).

$12,170,000—**Lockheed Aircraft Corp.**, Sunnyvale, Calif., for production of *Agena* space vehicles and for research and development on satellite systems (4 contracts).

$6,970,000—**AVCO Corp.**, Wilmington, Mass., for research and development testing, ground equipment and related work on a re-entry vehicle.

$6,800,000—**Martin Corp.**, Denver, for development and test of the *Titan I* missile at Vandenberg AFB, Calif.

$3,500,000—**Collins Radio Co.**, Dallas, for antennas for hardened missile sites.

$3,020,000—**Aerojet-General Corp.**, Sacramento, Calif., for production of Stage II motors for *Minuteman* missiles.

$2,714,033—**FMC Corp.**, New York City, for production of dimethylhydrazine propellant.

$2,369,265—**Douglas Aircraft Co.**, Santa Monica, Calif., for modification of and provision of launch services for *Thor* missiles

$2,141,542—**United Technology Corp.**, Sunnyvale, Calif., for research, design and demonstration of advanced components for solid-propellant rocket motors.

$1,803,000—**Western Electric Co.**, New York City, for production, installation and checkout of ground and missile-borne guidance equipment.

$1,800,000—**General Electric Co.**, Syracuse, N.Y., for production of airborne guidance equipment and furnishing test support of missile and satellite programs.

$1,500,000—**American Bosch Arma Corp.**, Garden City, N.Y., for continued research and development for the *Atlas* missile inertial guidance system.

$1,472,799—**Radiation Inc.**, Melbourne, Fla., for high-gain telemetry antenna systems.

$1,350,000—**Northrop Corp.**, Van Nuys, Calif., for target missiles.

$333,190—**United Technology Corp.**, Sunnyvale, Calif., for development of nondestructive testing technique for large solid-propellant rocket motor.

$94,851—**Rocketdyne, a div. of North American Aviation,** Canoga Park, Calif., for a service program for determining the performance of rocket propellant.

$94,487—**Ampex Instrumentation Products,** Dallas for speed control system and recorder.

$67,500—**IBM Corp.**, Rockville, Md., for engineering services for *SAGE* systems.

ARMY

$3,948,308—**The Greenhut Construction Co., Inc.**, Pensacola, Fla., for construction of a research and development facility for the Army Ordnance Missile Command at Redstone Arsenal, Huntsville, Ala.

$2,738,270—**Raytheon Co.**, Bedford, Mass., for radars for, and the development, testing and evaluation of the *Hawk* guided missile system.

$496,114—**Martin Construction Co.**, Cocoa Beach, Fla., for construction of a missile checkout building to be used in connection with the *Polaris* program.

INDUSTRY

$2,000,000—**Collins Radio Co.**, Dallas, from **International Electric Corp.**, for data transmission equipment to be used at strategic missile sites.

$175,000—**General Precision Inc., Kearfott division,** Little Falls, N.J., from the **Boeing Co.**, for components of the *Bomarc* flight control system.

$75,000—**Catalytic Construction Co.**, Philadelphia, from the **Boeing Co.**, for installations of weapons support equipment at three *Bomarc* bases on the East Coast.

NASA

$1,700,000—**Air Products and Chemicals, Inc.**, Allentown, Pa., for fabricating, installing and placing in operation a liquid hydrogen handling system for the *Saturn* vehicle, work to be done at Cape Canaveral.

$366,556—**North American Aviation,** Canoga Park, Calif., for investigation of multichamber engines and unconventional injector feasibility.

$307,710—**Fluidyne Engineering Corp.**, Minneapolis, for services and materials for nitrogen gas super-pressure temperature apparatus.

$296,664—**Aerojet-General Corp.**, Sacramento, Calif., for studies of high-chamber-pressure for launch vehicle engines.

$250,000—**Chance Vought Corp.**, for study of rendezvous of space vehicles.

$196,022—**Sperry Gyroscope Co.**, Great Neck, N.Y., for rocket engine analyzer and decision instrumentation.

$96,212—**Fairchild Stratos Corp., Aircraft Missiles Div.**, Hagerstown, Md., for design, fabrication, testing and delivering 3 flight assemblies for solar internal power project and required prototype test assemblies.

$50,840—**Electro-Mechanical Research, Inc.**, Washington, D.C., for discriminator, transistorized sub-carrier.

NAVY

$27,000,000 — **General Dynamics/Pomona,** Calif., for continued production of advanced *Terrier* and *Tartar* guided missiles.

$7,500,000—**General Electric Co.**, Pittsfield, Mass., for guidance and special test equipment for *Polaris* missiles.

$2,346,185—**Fairchild Camera & Instrument Co.**, Clifton, N.J., for a closed-loop television system for *Talos* missiles.

$1,970,000—**General Dynamics/Pomona,** Calif., research and development of the *Typhon,* improved *Tartar* and the advanced *Terrier* missiles.

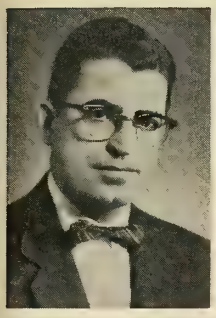
$579,523—**The Bendix Corp., Red Bank Div.**, Eatontown, N.J., for *ASROC* depth charge adaption kits.

$180,875—**E. W. Bliss Co.**, Canton, Ohio, for lowering rocket hoist 26 ft. high for use with *MK 108* rocket launcher.

$65,650—**Brush Instruments Div. of Clevite Corp.**, Cleveland, for repair parts for *Polaris* program.

$46,463—**Machinery Service Ltd.**, Honolulu, for service tower for TLM-18 antenna, Pacific Missile Range facility.

names in the news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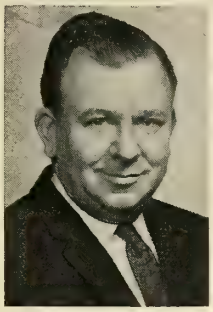
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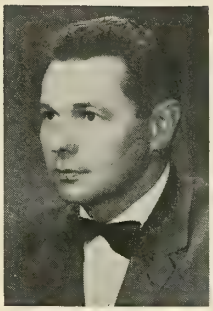
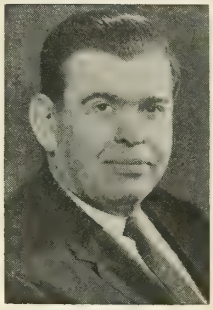

WILSON


STEIN

Scully-Jones and Company has announced the following management assignments and responsibilities: **J. Dudley Lockrem,** while remaining as vice president and secretary of the company, is now chairman of the board of Scully-Anthony Corp.; **Leonard H. Skoglund, Jr.,** is now president of Scully-Jones International and retains the position of vice president-finance and treasurer for the parent company; **Arch Johnston** becomes assistant to the president of Scully-Jones International, as well as assistant to the vice president-finance of Scully-Jones and Company. For the parent company, **Joseph Kosinski,** former works manager, has been made vice president-manufacturing; **Albert W. Drantz,** former assistant chief engineer, promoted to chief engineer; **James C. Rodgers** has joined the company as director of marketing; **Orvil Matteson** has been promoted to controller; and **James Sklenar** is manager of customer service and distributor relations.

William Mark: Placed in the newly created corporate position of vice-president-sales of the Van Keuren Company, Watertown, Mass.

Herbert D. Bissell: Promoted to vice president, corporate marketing, by the Minneapolis-Honeywell Regulator Co.

Carrol M. Shanks: Former president of Prudential Insurance Company of America, has been elected to the board of directors of WEMS, Inc., Hawthorne, Calif.

Charles J. Seeley: Has joined Rixon Electronics, Inc., Silver Spring, Md., as senior vice president for marketing and general administration.

Dr. Paul Rosenberg: Director of research of Paul Rosenberg Associates, Mt. Vernon, N.Y., named chairman of the Aerospace Technology Panel for Communications, Institute of the Aerospace Sciences; **Dr. John R. Pierce,** director of research communications principles, Bell Telephone Laboratories, Inc., Murray Hill, N.J., and **Harry I. Davis,** deputy assistant secretary, U.S. Air Force, have been named as members of the Panel.

Thomas I. Paganelli: Made general manager of the General Electric Company's Heavy Military Electronics Department, Syracuse, N.Y.

Ervin J. Osterhus: Elected president of Designers for Industry, Inc., to succeed **Charles H. Standish,** advanced to chairman of the board.

Joseph Kelley, Jr.: Has joined Telecomputing Corporation, Los Angeles, Calif. as vice-president for corporate development. He will conduct activities from corporate offices in Washington, D.C.

S. S. Wilson: While continuing to function as Sel-Rex Corp., Nutley, N.J., vice president of sales, has been elected president of the Meaker Co., a subsidiary.

Tucker E. Nason: Former sales manager of Long-Lok Corp., Los Angeles, promoted to the post of vice president, sales.

Dr. Edward V. Somers: To head up as manager a new research department recently created at the Westinghouse research laboratories.

Clarence J. Sellner: Appointed to the new position of director of manufacturing at Physical Sciences Corp., Pasadena, Calif.

Peter R. Rossmann: Joins National Forge Company as director and vice president in charge of all manufacturing operations, engineering, research and development.

Philip A. Matcovich: Named to a new position as director of manufacturing for the Bulova Research and Development Laboratories division of Bulova Watch Co.

Leonard Mansky, Jacob Schacter and **Arthur De la Parra:** Given new engineering management posts in Loral Electronics Corp. as follows: Mansky, made manager, Antenna Group; Schacter, manager, Advanced Systems Techniques Laboratory; and De la Parra, staff manager, Manufacturing engineering.

George W. Keown: Vice president for marketing at Tung-Sol Electric Inc., elected to the company's board of directors.

J. Paul Jordan: Vice president of Gulton Industries, Inc., Metuchen, N.J., named general manager of the company's Materials and Ceramics Div.; **Arthur S. Westneat, Jr.,** made technical director, Advanced Electronics; **Edward Hebditch,** general manager of the Energy Sources and Alkaline Battery Div.; **Robert G. Day,** continuing as manager of Gulton's scanner systems group, has been appointed general manager of the Ortholog Div.; and **Dr. Robert Shair** has been named manager of energy sources research and development in the Alkaline Battery Div.

Lynn Spence and **Charles Clement:** Have joined Pan American World Airways' Guided Missiles Range Division, Patrick AFB, Fla. as engineer in charge of the Betatron X-ray generator and instrumentation planning engineer, respectively.

Norman P. Hays: Eastern representative of North American Aviation, Inc., has been elected a corporate vice president.

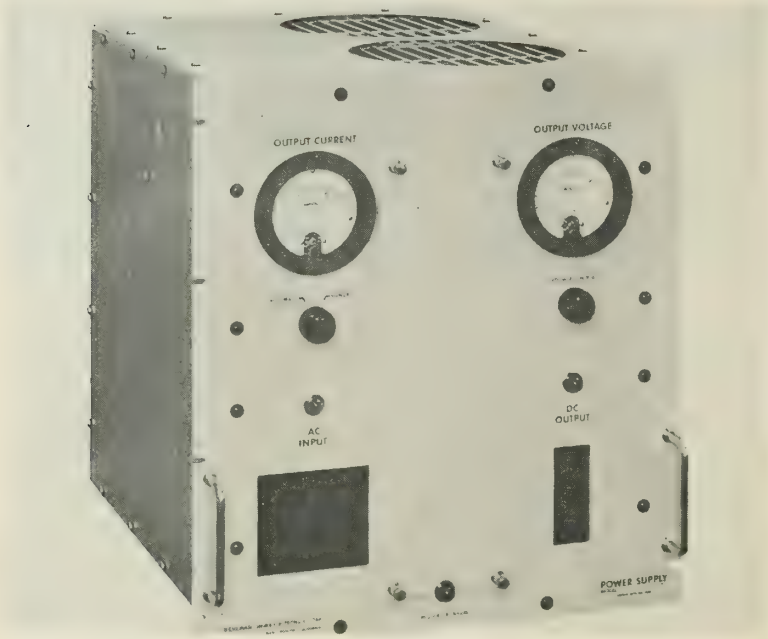
Dr. Douglas Courtney: Senior vice president of Matrix Corp., Arlington, Va., has been made a member of the board of directors.

Irwin D. Stein: Becomes affiliated with Power Designs Inc., Westbury, L.I., N.Y. as vice president.

H. S. Morris: Former marketing director of Altec Lansing Corp., Anaheim, Calif., has been made vice president of Marketing, and **C. R. Rininsland,** controller of the corporation, has become vice president-finance.

Walter F. Burke: Vice president and general manager of McDonnell Aircraft Corp., St. Louis, now a member of the board of directors of the company.

Gen. Don Flickinger: Former director of life sciences for the U.S. Air Force, has joined the Instrument Division of Lear, Inc., as a consultant in the field of man-machine problems.



New Product of the Week:

DC Power Supply

BEHLMAN-INVAR Electronics Corp. has available a fully transistorized 100-amp dc supply adjustable from 22 to 32 VDC. Specifically designed for missile ground support equipment, qualified to MIL-1-6181, the unit can be operated from 208, 230, or 460 VAC, 3 phase, 57-63 cps, and provides an output which is regulated to better than 10mV for either ±10% line changes or 0 to full load changes.

Ripple is less than 5mV and the unit features a special construction which results in exceptionally low load transients. Complete electronic short circuit protection is also provided. Each power transistor is individually fuse-protected and failure is visually displayed.

Circle No. 225 on Subscriber Service Card

Precision Timing Device

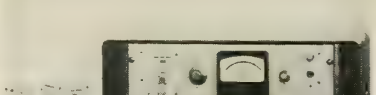
John Oster Manufacturing Co., Avionic Div., has developed a precision device with three-switch and one-potentiometer actions as a function of time. The device utilizes a reversible synchronous motor for a time base, an electromagnetic clutch-brake, relays, microswitches and Geneva-type actuating mechanisms. Design permits flexibility of timing functions and adding more switches.

Circle No. 226 on Subscriber Service Card

Tunable Microvoltmeter

A tunable microvoltmeter, developed by the Instrumentation Div. of Infrared Industries, Inc., for use in applications requiring transducer noise-limited operations, is continuously tunable from 10 to 10,000 cycles/second or 1 to 1000 cycles/second depending on the model. Gain variation with change of frequency and/or bandwidth is less than 3 db over the entire tuning range. Maximum full-scale sensitivity of the instrument is 0.003 microvolt when combined with the appropriate preamplifier.

Circle No. 227 on Subscriber Service Card



Analog-Digital Converters

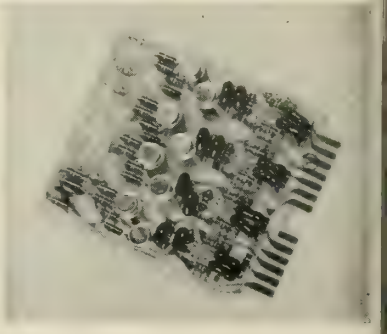
A series of analog-digital converters guaranteed to maintain a basic accuracy of ±0.01% for six months is available from Systems Div. of Beckman Instruments, Inc. The instruments are all-solid-state and built to standard 19-in. rack dimensions.

An important feature of the new instrument is the electrical isolation of digital input and output lines from conversion circuits during decision-making intervals. This prevents external noise from interfering with internal, low-level signals, and significantly improves precision of the converter.

Circle No. 228 on Subscriber Service Card

Binary Counter

Control Equipment Corp. is marketing a Binary Counter BC-501 Digital Module. It consists of four standard flip-flop circuits connected as a binary counter. It counts from 0 through 15 in a standard binary code at frequencies



from 0 to 250 kc. The unit has an a-c coupled count input and a a-c coupled direct reset input. Both the "one" and "zero" outputs are available from each flip-flop. The binary counter will drive other modules in the company's line directly from each output.

Circle No. 229 on Subscriber Service Card

Ultra-Fast Recovery Diodes

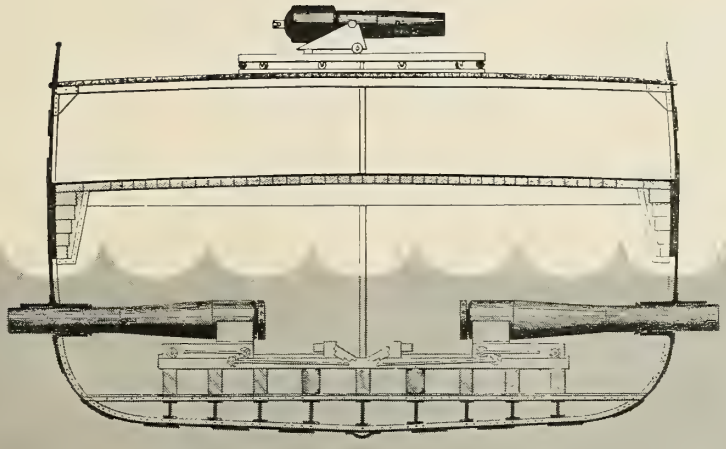
Micro State Electronics Corp., is producing diodes with 0.5 nanosecond recovery time. Types MS 2540 and MS 2541 are diffused junction mesa diodes with the low-charge storage characteristic of gallium arsenide devices. Both types have a hermetically sealed ceramic and metal package, making it possible to operate these units at 200°C. Both have minimum breakdown voltages of 6 volts, with the maximum current at breakdown being 0.1 μa for MS 2540 and 1.0 μa for MS 2541.

Circle No. 230 on Subscriber Service Card

ARMED FORCES MANAGEMENT'S
SPECIAL REPORT
"ANTI-SUBMARINE WARFARE"

issue date: april, 1962

advertising closing date: march 19, 1962



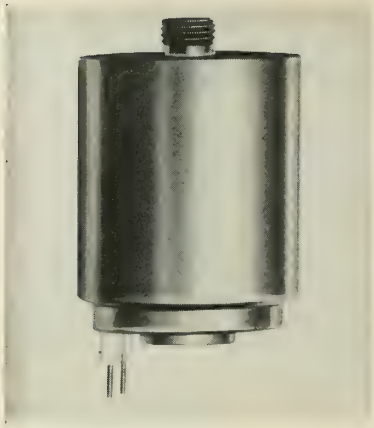
we've come a long way . . .
but not far enough

This primitive anti-submarine weapon would have been relatively successful in the 19th century. It would hardly be effective in modern warfare.

Many defense and industry leaders say today's ASW systems are equally primitive in relation to nuclear powered submarines. Navy intends to develop a clear-cut, cohesive ASW program, especially for R&D. This signifies a better and more profitable ASW market for industry, one where Navy will finally support industry's solutions to the complex ASW problems.

AFM'S April Issue will report ASW's current status and future trends. It will include: A profile of Vice Admiral Raborn, who will bring fresh, new management to ASW R&D efforts/Navy's official view of the ASW threat/Industry's opinion on Navy's management of ASW resources/Unofficial views from Naval authorities/ASW trends and future material requirements.

Every Defense official involved in ASW will read this issue . . . tell them of your products and capabilities before the "buy decisions" are made by advertising in AFM'S "ASW Report" issue.



Solenoids

A line of solenoids capable of continuous operation in temperatures exceeding 1000°F have been developed by Rocker Solenoid Co. This high temperature line incorporates a unique method of coil-and-bobbin manufacture which increases continuous ratings for advanced aerospace applications where engine and re-entry temperatures render conventional solenoids obsolete.

Circle No. 231 on Subscriber Service Card

Silicon NPN Transistors

Four epitaxial silicon transistors are available from National Semiconductor Corp. Designed for high-speed switching circuits and high-frequency amplifiers, these devices feature low saturation resistances and high breakdown voltages. These transistors are designated NS 381 to 384 and are produced in the T0-18 package. Epitaxial configuration cuts storage times to 12 nanoseconds for NS 383 and NS 384 and to 15 nanoseconds for NS 381 and NS 382. These storage times are less than half those possible with straight planar or mesa transistors.

Circle No. 232 on Subscriber Service Card

Rotary Switches

Mason Electric Corp.'s, series "L" miniature rotary switches, designed for standard and custom applications, use less than half the part of conventional switches. They may be used as a 1 pole 12 position through any grouping to 6 pole 2 position and each of 12 positions may be separate pole by simple deletion of jumpers. Designed to fulfill all applicable military and Navy specifications, they have a maximum dia. of 1 31/64 in.

Circle No. 233 on Subscriber Service Card

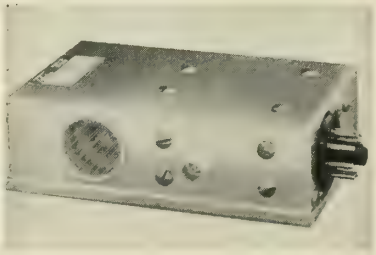
Vibration Exciter

A high-frequency, high-force vibration exciter is available from the Industrial Products Div. of International Telephone and Telegraph Corp. The machine is for research and development, high-level quality control, and for testing to failure small devices such as transistors, capacitors, and resistors over a wide frequency range. The device provides accelerations to well above 100 g for loads of less than one ounce at frequencies to above 20 kilocycles per second. The frequency response is flat to the first resonance at 11 kc; output is useful to about 50 kc. The wide bandwidth makes the exciter usable for testing with wide-band noise.

Circle No. 234 on Subscriber Service Card

CW Oscillator-Amplifier

An oscillator providing accurate CW signals and available in a broad range of frequencies has been announced by Telonic Industries, Inc. A plug-in, crystal-controlled unit that serves as a sim-



ple, inexpensive source of CW for the instrumentation or systems engineer requiring such signals, the oscillator is available in any frequency from 200 kc to 75 mc, with an accuracy of $\pm 0.005\%$.

Circle No. 235 on Subscriber Service Card

Solder Gobbler

Air-Vac Engineering Co., is marketing a hand tool for cleaning up solder melted with a soldering iron. It operates on a vacuum, drawing molten particles into its pyrex glass body. A specially designed air baffle in the exit fitting forces the solder to collect on the inside of the glass tube. Heat is not a problem with the Teflon tips or the pyrex body. When enough solder collects in the tube, it is a 10-sec. job to run a brush, provided with each Solder Gobbler, through the tube for cleaning out.

Circle No. 236 on Subscriber Service Card

new literature

ASTM-STEEL PIPING—The 18th Edition of *ASTM Specifications for Steel Piping Materials-A-1*, published by the American Society for Testing and Materials, contains 76 standards to aid those concerned with pressure piping, power generation, and the production of petroleum and petroleum products and for others interested in general engineering applications of steel tubular products. The publications was compiled by Committee A-1 on Steel and contains four new items not included in the 1960 volume.

Circle No. 200 on Subscriber Service Card

ENCODER BULLETIN—A four-page bulletin gives detailed electrical and mechanical specifications on the Model 213, 1000 counts per revolution, shaft position encoder from AR&T Electronics, Inc., subsidiary of The Baldwin Piano Co. Angular shaft displacement is converted into electrical signals for a 12-digit readout (3 four-digit binary notations). Complete and comprehensive code derivation/explanation is included.

Circle No. 201 on Subscriber Service Card

INERT-GAS/AIR SELECTOR.—Described in bulletin 61-5, by Kamweld Products Co., includes method of operation, photograph, functions of gas selector and safety control. This selector and safety unit is designed for use with one or two thermoplastics welders operating with either inert-gas or compressed air.

Circle No. 202 on Subscriber Service Card

BERYLLIUM COPPER—Application of beryllium copper in electronic circuitry is described in a bulletin available from The Beryllium Corp. The bulletin describes the requirements of parts that are used in missile guidance computers and tells why beryllium copper was selected. Two separate beryllium copper alloys are used in the application covered by the bulletin. Complete information is provided on the method and technique used to form the complex parts.

Circle No. 203 on Subscriber Service Card

ENGINEERING REPORTS — Datametrics has launched a series of Technical Bulletins directed at providing the engineer with technical information on new developments. No. 1 tells about a new type of electromechanical data sampling switch that provides noise-free operation and virtually unlimited life. No. 2 describes a type of differential pressure transducer which will measure pressure differentials from 1×10^{-6} psid to 25 psid.

Circle No. 204 on Subscriber Service Card

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Electronic Industries Association Spring Conference, Statler-Hilton Hotel, Washington, D. C., Mar. 13-16.

Goddard National Space Conference, sponsored by the National Rocket Club, Sheraton Park Hotel, Washington, D.C., Mar. 14-16 (Goddard Memorial Dinner on Mar. 16).

Electric Propulsion Conference and Scientific Display (classified), **sponsored by American Rocket Society,** Hotel Claremont, Berkeley, Calif., Mar. 14-16.

National Association of Corrosion Engineers, Annual Conference and Corrosion Show, Municipal Auditorium, Kansas City, Mo., Mar. 19-23.

Second National Symposium on Hypervelocity Techniques, Denver Research Institute, University of Denver, Colo., Mar. 20-21.

Symposium on High-Temperature Solution Chemistry, American Chemical Society and Office of Aerospace Research, Chemical Sciences Directorate, Washington, D. C., Mar. 20-26.

American Chemical Society National Meeting, Washington, D. C., Mar. 20-29.

Society for Industrial and Applied Mathematics Spring Meeting, California Institute of Technology, Pasadena, Mar. 23-24.

International Convention of Institute of Radio Engineers (IRE), Coliseum and Waldorf-Astoria Hotel, New York City, Mar. 26-29.

Third Symposium on Engineering Aspects of Magnetohydrodynamics, sponsored by Univ. of Rochester, AIEE, IRE, IAS, Univ. of Rochester, N. Y., Mar. 28-29.

APRIL

Launch Vehicles: Structures and Materials Conference, sponsored by the American Rocket Society, Ramada Inn, Phoenix, Ariz., April 3-5.

Second Symposium on the Plasma Sheath, sponsored by Electromagnetic Radiation Laboratory, Electronics Research Directorate, L. G. Hanscom Field, Mass., April 3-5.

Nineteenth Annual Conference, Society of the Plastics Industry Western Section, Hotel Del Coronado, Coronado, Calif., April 4-5.

American Society for Quality Control Workshop—Seminar on Management of Quality Control, Hollywood Roosevelt Hotel, Los Angeles, April 4-6.

American Institute of Electrical Engineers South Central Meeting, Hotel Peabody, Memphis, April 4-6.

Thirteenth Annual Advanced Statistical Quality Control Institute, Univ. of Connecticut, Storrs, April 8-20.

American Institute of Electrical Engineers, Rubber and Plastics Industries Conference, Sheraton Hotel, Akron, April 9-10.

Instrument Society of America, National Chemical and Petroleum Instrumentation Symposium, Wilmington, Del., April 9-10.

Thirty-third Annual Scientific Meeting of Aerospace Medical Association, Chalfonte-Haddon Hall, Atlantic City, N. J., April 9-12.

American Society of Mechanical Engineers, Metals Engineering Conference, Sheraton-Cleveland Hotel, Cleveland, April 9-13.

Spring National Convention, Society of Nondestructive Testing, Pick-Carter Hotel, Cleveland, April 9-13.

Southwest Conference and Electronics Show, sponsored by IRE, Rice Hotel, Houston, April 11-13.

Regional Technical Conference, Society of Plastics Engineers, University of Rochester, N. Y., April 12.

Conference on Refractory Metals, American Institue of Mining, Metallurgical, and Petroleum Engineers, Morrison Hotel, Chicago, April 12-13.

American Physical Society, Plasma Physics Symposium, Hilton Inn, Tarrytown, N. Y., April 13-14.

Second Conference on Kinetics, Equilibria, and Performance of High Temperature Systems, Western States Section of the Combustion Institute, University of California, Los Angeles, April 14-16.

Thermodynamics Conference, Oklahoma State University, Stillwater, April 16-17.

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The 'AIAA'—and What Should Follow

DETAILS OF THE proposed constitution and by-laws of the American Institute of Aeronautics and Astronautics which would emerge from a consolidation of the American Rocket Society and the Institute of the Aerospace Sciences are carried elsewhere in this issue (p. 38).

We wholeheartedly support the plan for a merger of the two organizations. This, and the proposed merger of the 70,000-member American Institute of Electrical Engineers with the 90,000-member Institute of Radio Engineers, could do much to eliminate the confusing and time-consuming overlap between some of the industry's major technical societies.

There are several things about the projected ARS-IAS merger which concern us, however.

The statement attributed to ARS President W. H. Pickering that the consolidation will not result in fewer meetings, although it will produce meetings of more value, is disappointing.

We had hoped that one outstanding result of the ARS-IAS and AIEE-IRE mergers would be a reduction in the number of technical meetings forced upon the industry. These are costly both in money and in time.

Last October, Dr. Pickering himself pointed out that industry spends $100 million annually on these meetings. He called on the various societies to hold meetings only when sufficient timely and high-quality papers are available.

We certainly hope the new AIAA will hold fewer technical sessions than the combined ARS and IAS total. If not, one of the worthwhile objectives of the merger will have been lost.

We favor the proposed consolidation of the two societies because the trend of technological development in the industry has resulted in a large overlap in the objectives of the rapidly expanding ARS and what used to be the Institute of Aeronautical Sciences. It was, indeed, this very trend that inspired the change from "aeronautical" to "aerospace" in the IAS name.

IAS President L. Eugene Root has made this same point:

"At the outset of these studies, motivation came largely from a desire on the part of both societies to reduce apparent and growing overlaps in the schedules of meetings and in technical subjects. . . ."

We therefore face the merger of a society devoted *entirely* to astronautics with one now devoted *largely* to astronautics, with a small but active group still interested in the aeronautical field.

This split in the two disciplines of astronautics and aeronautics is evident in the proposed name for the new society—American Institute of Aeronautics and Astronautics.

But nowhere in the proposed constitution and by-laws do we find any recognition of this diversity. The suggested structure makes no provision for a separation of the group into astronautical and aeronautical functions.

We hope the working groups will give some consideration to this. Astronautics and aeronautics are separate disciplines serving what now are separate industries.

Consolidation of the ARS and IAS interests in the astronautical field is welcome. But to intermingle aeronautics with this grouping will only bring into the ARS body a confusion that already is a problem for the IAS. Much of what opposition there is to the merger stems from the fears of the aeronautical group that it will be lost in the combined Institute. This is a legitimate concern which should be recognized.

WE WOULD LIKE to see the AIAA structure make provision for the separate aeronautical interest. This should include separate technical meetings and perhaps a separate publication or publications. Both the astronautical and aeronautical disciplines would be served by such a division.

In fact, once the major benefit of the merger has been achieved—the grouping into a single body of the astronautical interests of the two organizations—we can see a great deal to recommend again splitting off aeronautics into a separate society, perhaps re-establishing it once more as the Institute of Aeronautical Sciences.

Each industry and discipline thus would benefit from a purifying of its major technical body. It still is too early to plan such a development, for at this time it would only confuse the projected merger. But some forethought should be given to this eventuality in setting up the structure of the new AIAA.

Final study report of the IAS-ARS steering committee is due in May. The two organizations then will decide independently on a consolidation plan to be submitted to the memberships for a vote.

We hope every member will take enough of an interest to cast his vote, whether for or against. Nothing would be more saddening than to see the proposed consolidation fail because the memberships were too lethargic to provide the necessary majority.

William J. Coughlin

This thin panel stopped a meteorite

(man-made, traveling at 21,000 feet per second)

A steel pellet struck this panel at 21,000 feet per second — more than six times the speed of a high powered rifle bullet — but could not pierce it. It disintegrated after puncturing the outer metal skin, and dissipated all its energy without reaching the inner lining.

This composite honeycomb panel is one of the techniques Northrop is developing to protect spacecraft against meteorite collisions. The entire lightweight panel is less than half an inch thick, and the honeycomb is filled with sealant to prevent air from escaping in case a particle should ever penetrate.

Though most of the meteorites a spacecraft is likely to encounter will be fine as dust, some may be as large as buckshot, and dense enough to puncture an ordinary metal skin. The search for materials to meet this hazard is another example of Northrop's practical work on the problems of space.

NORTHROP

DESIGNED FOR DIVERSITY

Aerojet's multi-purpose drone

The AN/USD-2 drone is designed to serve the field commander on tomorrow's battleground. Rugged and reliable, the current AN/USD-2 will provide a capability for day and night battlefield surveillance, demonstrated in full-duration flights under Army cognizance.

An advanced AN/USD-2, proposed for development, would be a mobile multi-purpose system with expanded capabilities.

SURVEILLANCE of enemy territory
DIVERSIFIED PAYLOAD capability

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MARCH 19, 1962

missiles and rockets

THE MISSILE/SPACE WEEKLY

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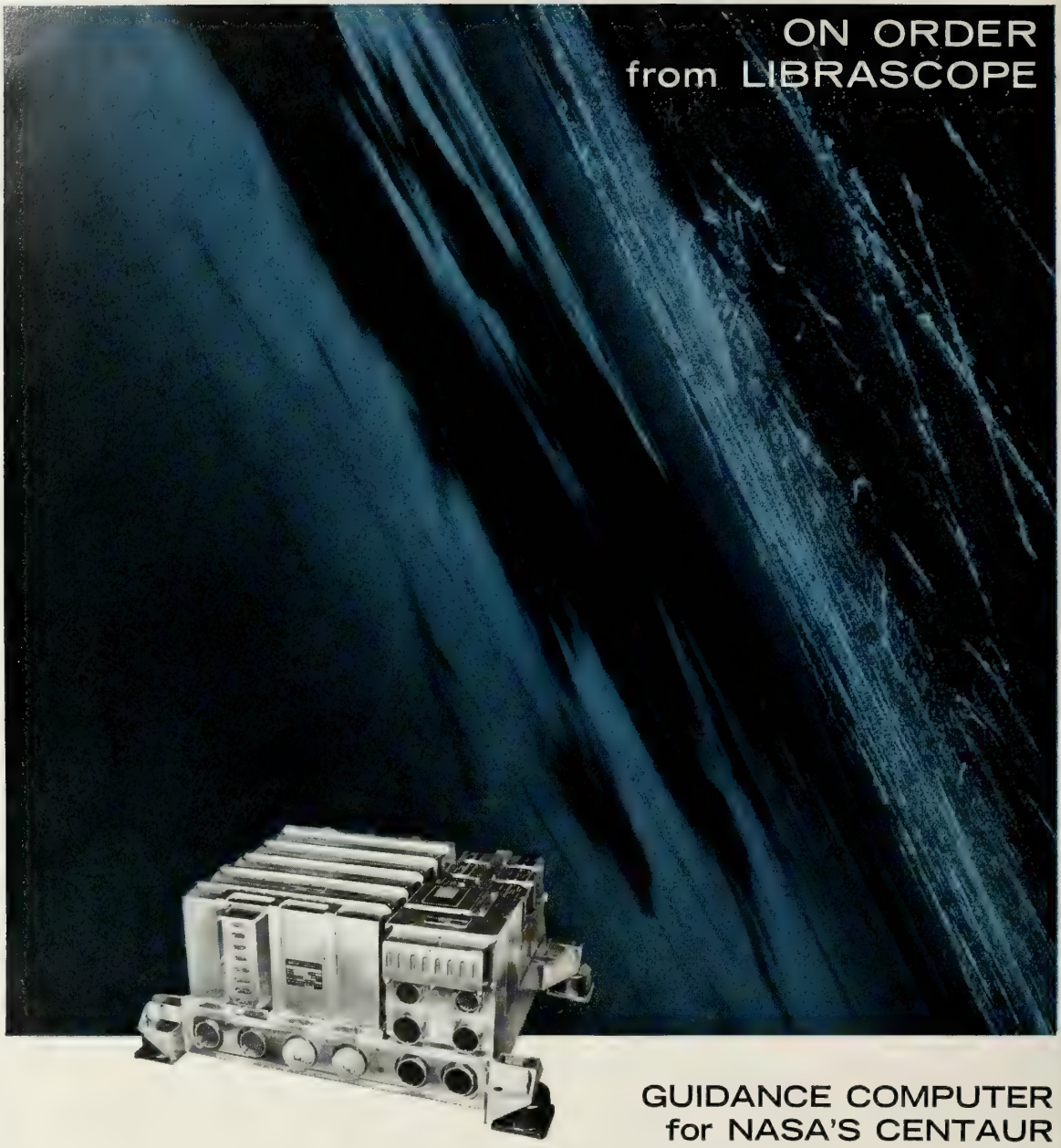
AN AMERICAN AVIATION PUBLICATION



GUIDANCE COMPUTER for NASA'S CENTAUR

Sometime this year, CENTAUR will be spaceborne. Already, the projected uses of CENTAUR bear fascinating implications for the future... placing a satellite in an orbit so exacting that it will remain in one spot over the earth's surface... soft landings on lunar and planetary bodies... timed launchings of several satellites from a single vehicle. Several major guidance functions will be performed in CENTAUR by a compact digital computer system from Librascope. It weighs 62 pounds, occupies little more than ¾ cubic foot. A note to Librascope outlining your control problems will bring a prompt answer from the country's most versatile manufacturer of computer control systems.

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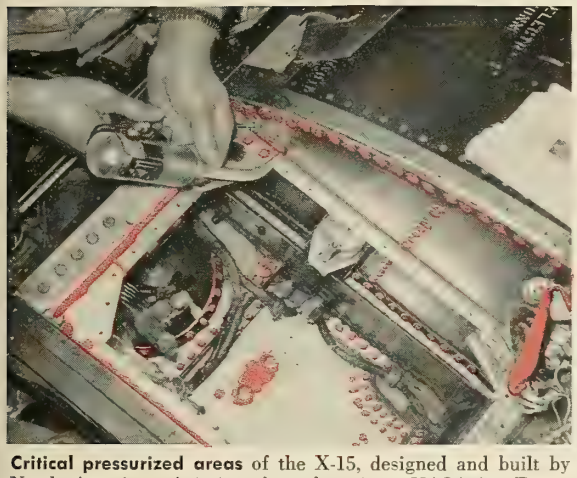
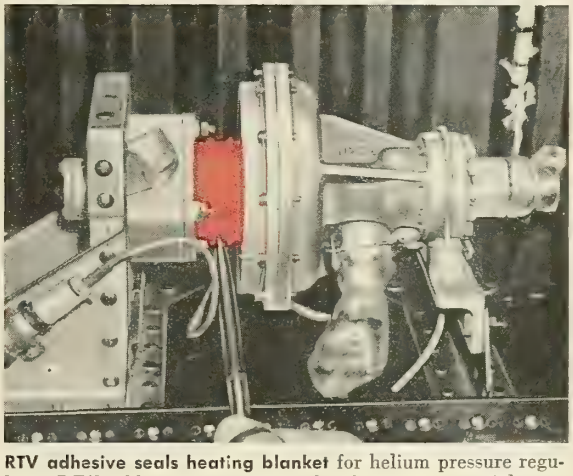
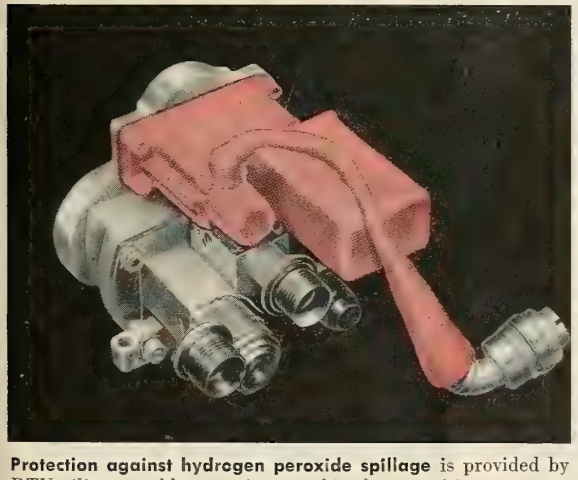
GENERAL ELECTRIC RTV SILICONE RUBBER KEEPS THE PRESSURE IN THE X-15!



Critical pressurized areas of the X-15, designed and built by North American Aviation through a joint NASA-Air Force-Navy research project, are sealed with General Electric RTV (room temperature vulcanizing) silicone rubber. After a thorough analysis of all high temperature sealants, RTV was selected to seal the aft bulkhead behind the cockpit, instrumentation compartment and shelving near the ship's mid-section.



RTV adhesive seals heating blanket for helium pressure regulator. RTV rubber forms tenacious bonds to most materials provided surfaces are properly primed. It is easily removed from unprimed surfaces. It can be applied by dipping, pouring, spraying or buttering—cures in place at room temperature to form a tough, flexible seal. Cure times can be varied from minutes to hours depending on catalyst used and heat, if applied.



Protection against hydrogen peroxide spillage is provided by RTV silicone rubber coating on this three position actuator. RTV is commonly used to protect against moisture and many chemicals. It's used in almost all U.S. missiles and space vehicles, not only for sealing, but for electronic potting and encapsulating, and as thermal insulation. It combines excellent electrical properties with physical protection.

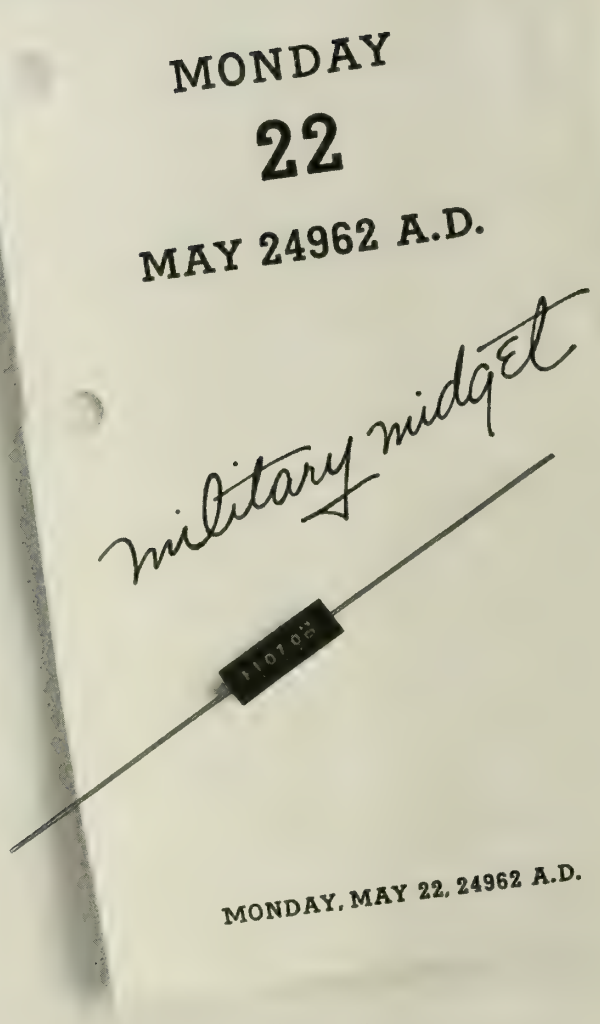
If you would like a free sample for evaluation, write on your letterhead, describing your application. Section 0366, Silicone Products Department, General Electric Co., Waterford, N. Y.

TYPICAL PROPERTIES OF RTV SILICONE RUBBER

	RTV-11	RTV-20	RTV-40	RTV-60	RTV-77	RTV-88	RTV-90
Viscosity, Poises	120	300	450	550	8,000	10,000	12,000
Color	White	Pink	White	Red	White	Red	Red
Consistency	Easily Pourable	Pourable			Spreadable Thixotropic Paste		Stiff Paste
Temperature Resistance	FROM −90°F TO +600°F FOR EXTENDED PERIODS TO 9,000°F FOR LIMITED TIME AS THERMAL INSULATION						
Specific Gravity	1.18	1.35	1.37	1.47	1.33	1.47	1.47
Radiation Resistance	10^7 ergs/gram						
Tensile Strength, psi	350	450	550	650	500	750	750
Shrinkage, %	0.4	0.2	0.2	0.2	0.3	0.3	0.2
Durometer, Shore A	45	50	55	60	50	65	60
Volume Resistivity, ohm-cm	$6x10^4$	$5x10^3$	$1x10^{14}$	$2x10^4$	$1x10^{15}$	$1x10^{14}$	$2x10^{14}$
Solids Content, %	100	100	100	100	100	100	100
Elongation, %	180	140	120	110	220	110	190

A wide range of RTV compounds meet a variety of application requirements. Low viscosity RTV-11 (or transparent LTV-602) is used for potting electronic assemblies and coil impregnation. RTV-77, 88 and 90 are mainly used for high-temperature sealing and for thermal insulating and ablative applications. Intermediate viscosities meet other insulating and sealing requirements, are also used as flexible mold materials.

GENERAL ELECTRIC



If this new type deposited carbon resistor were placed in service today, would it perform until 24962 A.D.?

Frankly, we do not expect a single resistor to last that long. However, this 23,000-year life span is expressed in another way—not more than one failure in 23,000 resistor years, or a rate of .0005%/one thousand hours in certain missile system resistors for which the Bell System is responsible.

Substantial numbers of laboratory tests predict that this high degree of reliability *will* be achieved over a reasonable span of years.

For missile systems employing millions of these resistors to be practical, the above failure rate must be attained. The Bell System—through its manufacturing and supply unit, Western Electric—found that manual methods of manufacturing were inadequate.

So a completely automated production process, utilizing a digital computer as the heart of the new system, was designed and built. It is the first of its kind. The computer maintains the necessary process controls throughout production in order to insure the high reliability required.

This dramatic example of the Bell System's communications dependability is another instance of the high standards applied to the Bell System's work in the nation's defense.

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THE MISSILE / SPACE WEEKLY

missiles and rockets

Volume 10, Number 12 March 19, 1962

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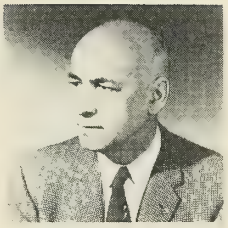
THE COVER

Robert R. Gilruth, director of Project Mercury, has been chosen 1962 winner of the Goddard Memorial Trophy for his leadership of the team that produced the first U.S. manned orbital flight. *See p. 15.*



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letters

On 'Best Guy' Procurement

To the Editor:

Just when the Defense Department seemed to be including incentive in government procurement through use of the Cost-Plus-Incentive Fee contracts, NASA is charging off in an opposite direction. Specifically, I refer to the recent awards made to MIT and GE on the *Apollo* program.

Certainly few could deny that these two great organizations are well qualified to handle these assignments. But the long-term effects of this "best guy," non-competitive procurement could have significant impact on the industry. Such a policy would reduce competition among firms, leave little incentive for companies to fund their own R&D programs, and could well propagate a new generation of senile firms. One more point—and I know this is unthinkable—such a policy could be used by an unscrupulous Secretary of Labor to advance "the cause" during an election year.

Quentin W. Fleming
Orange, Calif.

Tonsorial Approach

To the Editor:

Having just read the item headed "'Conflict' Uncertainties Resolved" (the President's memorandum on "conflict of interest" problems of government advisers and consultants, M/R, Feb. 19, p. 38), might I volunteer the services of my barber as the next director of NASA?

Despite the horrendous price we seem to pay for haircuts, my barber assures me that he does not own any stock in any of the companies working on NASA programs, nor does he own stock in any banks which might lend money to help capitalize programs for these companies. In fact, he is such a personal rowdy that his chances of having any type of estate for any length of time are practically nil.

His personal habits are such, in fact, to insure that even the most venal company would not hire him to "pick his brains" after he completed his assignment. This is very important, as you know.

His family situation is also ideal. Although he was acquitted in the case, the fact remains that he has absolutely no family ties left—and therefore, obviously, his "influence" can't possibly rub off.

He's probably too dumb to be dishonest, which is obviously a fine attribute in this particular instance.

I was assured by him, when I suggested he try out for the job, that he would be perfectly willing to make a clean breast of all remuneration, private employment, etc., so long as it was held as privileged information from the Internal Revenue Service.

In short, here is a man who really fills the bill. The perigee that we are obviously seeking to lead us.

The utter foolishness of "conflicts of interest" hoopla must be brought to the attention of thinking American people. If they have sunk so morally low as to disqualify every qualified person from holding public office because he might *possibly* lack the personal integrity to do his public duty, then we really in the final analysis will be faced with the situation described by my barber.

The rules and regulations which are being promulgated have obvious danger. The honest man won't touch government with a ten-foot pole. The dishonest man will not change his way of doing things, he'll simply get into the saddle, because he is the only one left with the minimal basic intelligence which could be swallowed by the persons required to make the appointments.

By violating a basic tenet in Anglo-Saxon law—that a person presumptively acts in a lawful and moral way—we are heading down the path of utter chaos.

What this country needs, of course, are the very people we disqualify on the altar of possible "conflicts of interest." The industrialists with the proven administrative capability; the engineer who has become the leader in his field; the retired military officer who appreciates the operational problems from first-hand experience. . . .

My God, how the Russians must laugh at us!

Frank Walker
Clinton, Md.

Solar Heating

To the Editor:

John Russell, the son of one of your subscribers and an astronomy student of mine, brought to my attention the series of articles on the outer planets by Robert L. Forward which you have been publishing.

I have read them, as far as the Uranus-Neptune one, with interest and pleasure; if I can separate the issues from John on a more permanent basis, I shall use them as reading assignments in my astronomy courses.

There was one slip, however, in the most recent series ("'The Twins'—most Hospitalble of Outer Planets?", M/R, Jan. 22, p. 35). Starting at the middle of the first column on p. 36, Mr. Forward refers to the radiation equilibrium temperature of a planet as being the *maximum* temperature which can be accounted for by solar heating. This is not the case; black body radiation equilibrium temperature represents, in general, a *minimum*. If an object is not a perfect radiator it will have to warm up still farther in order to radiate at the same rate as it is receiving energy. The earth, for example, is 10 to 15 Centigrade degrees warmer because of "greenhouse effect" than it would be if it lacked an atmosphere and were that much closer

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to being a "black body." The same effect seems to be far more pronounced on Venus, if the radio estimates of its surface temperature are justified.

This does not refute Mr. Forward's suggestion that there may be internal heating in the giant planets; but there are no present grounds that I know of for saying that this *must* be the case.

Harry C. Stubbs
Milton Academy
Milton, Mass.

Doppler MDI System

To the Editor:

We have noticed several discrepancies and omissions in the article entitled "A Gamma-Ray Miss-Distance Indicator" (M/R, Jan. 15), which we are sure you will wish to correct.

PARAMI and MATTS are not the only MDI systems in operational use. The Doppler system (not the Doppler *radar* system you mention) has been successfully used for years. The system, the AN/USQ-11 and -11A, has been developed by the Naval Ordnance Laboratory, and several manufacturers have been supplying components for it. . . .

A.R.F. Products, Inc., one of the system manufacturers, has been supplying components for this system since mid-1959. This system is in operational use at White Sands Missile Range for several rocket-type targets. A variation of the USQ-11A system will be used for the *Nike-Zeus* tests in the Pacific.

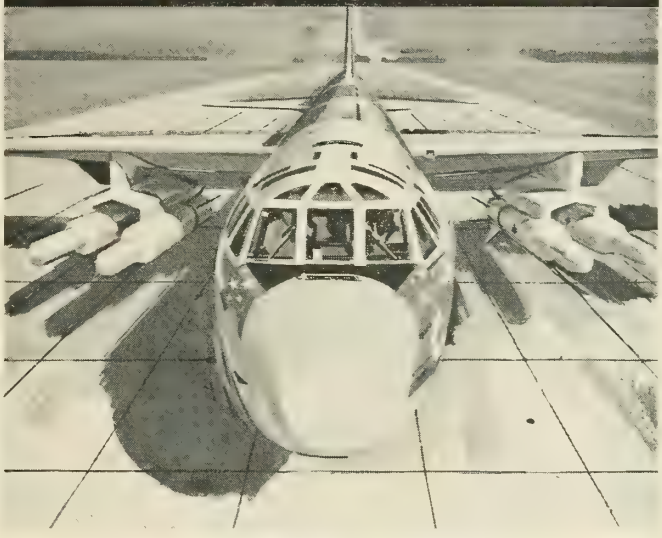
The Doppler MDI system has the advantage of providing both the closing velocity and miss-distance information for miss-distance from less than 10 ft. to over 1000 ft. with good accuracy, without equipment modification. No storage of radioactive materials is necessary, and both targets and missiles can be used directly from storage without special preparations.

The Doppler MDI system is practically non-cooperative. Since it requires only a telemetry transmitter on the missile, in most cases already present for data link use, no modifications are necessary and no restrictions are imposed on data transmission. The target transponder weighs less than 4 lbs. complete, when using the target power source, or less than 7 lbs. with self-contained batteries. (The Gamma-Ray MDI has to have a complete telemetry transmitter provided for transmitting data to the ground, besides the MDI equipment.) In weight (and in size) the Doppler MDI therefore has a definite advantage. Our experience indicates that even the 4-lb., 6-in.,-dia. by 3-in.-long MDI transponder may be too large for some of the targets, and a still smaller version is under development.

From the figures cited at the end of your article, it appears that the Doppler MDI system compares favorably in price with the Gamma-Ray MDI.

Andrzej Przedepelski
E/C I. & G. R. Dept.
A.R.F. Products, Inc.
River Forest, Ill.

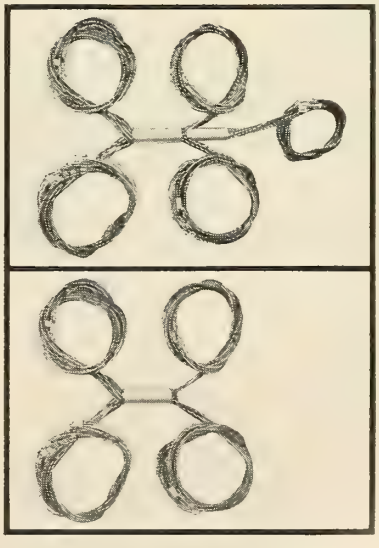
A Poly-Scientific First...

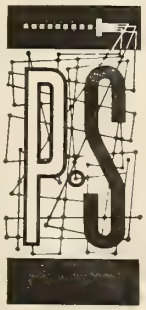


From Air Launch to Target, Poly-Scientific Capsule Slip Rings Assist in Guiding the (GAM87A) Skybolt Ballistic Missile.

Rotor of 133 rings, common to double stack stator.

Rotor of 75 rings and matching stator.





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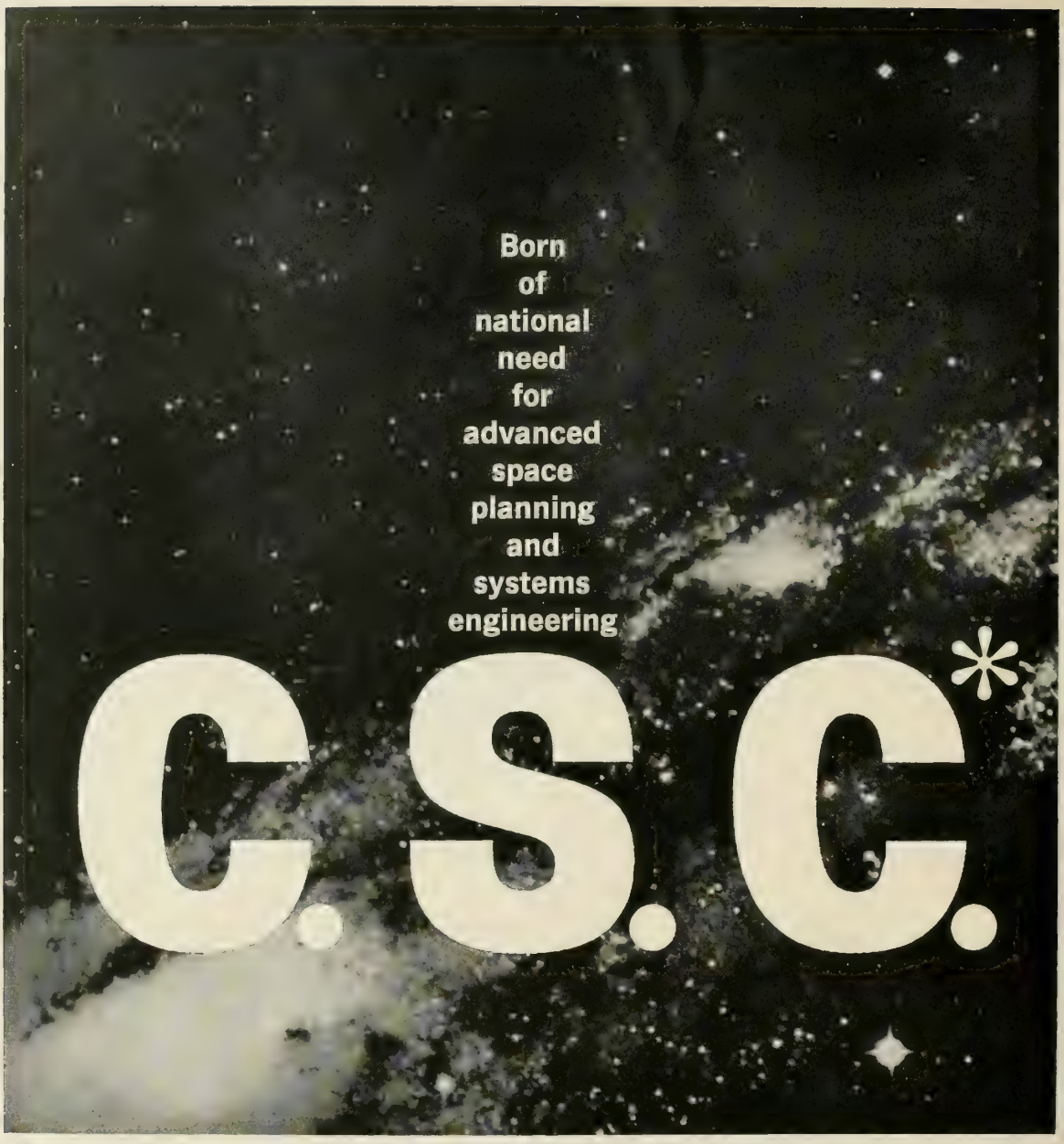

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The Countdown

WASHINGTON

New Spacecraft Planned

Next big step in the U.S. space effort will be a program for unmanned spacecraft which will return to earth with their payloads after lunar and interplanetary missions. Although none has yet been approved, NASA officials are studying a list of proposals for these new craft.

Limited Tests for ICBM Warheads

When the U.S. begins nuclear testing in the Pacific later this year, one of the most important series will be proof tests of existing ICBM warheads. These tests will not cover the full ICBM ranges, however, due to AF fears that the missiles might stray into atolls outside the test area.

NASA Views on Superbooster

With the current emphasis on orbital rendezvous for the first lunar-landing missions, NASA now considers the *Nova* superbooster as the main element in a transportation system to set up and supply a manned lunar base. With nuclear upper stages expected to be operational at about the same time as *Nova*, payload capability to escape velocity is expected to reach 300,000 lbs.

Soviet Missiles Phasing In

Air Force intelligence officers say the cross-over point in Soviet strategic reliance on missiles from aircraft now is expected to be reached in the mid-1960's. Manned aircraft are expected to remain an important element in the Russian striking force for the rest of the decade, however. Congressmen, meanwhile, are wondering about the value of our military intelligence. They say AF estimates of Soviet missile strength they received last September were only 3.5% of those in 1959.

Wallops Gets Walloped

The recent Atlantic storm disrupted operations at NASA's Wallops Island station but did little major damage. Most affected were radar equipment and the two *Scout* telemetry ships which were at sea during the storm. The *Scout* launch vehicle program will not be delayed. although other launches may slip about two weeks.

First International Satellite Scheduled

Launch of the first *S-51* international satellite now is scheduled from Cape Canaveral for next month. The joint United Kingdom-U.S. project will study cosmic and solar radiation.

INDUSTRY

Initial Titan II Launch Scheduled

First launch of Martin's *Titan II* storable missile with inertial guidance was scheduled for late last week at Cape Canaveral. Successful captive firing on March 9 built up full thrust of 430,000 lbs. for 20 sec. Total thrust of two-stage *Titan II* is 530,000 lbs.

Short Schedule for M-1 Engine

Although the contract was awarded only two months ago, the first M-1 liquid hydrogen engines are to be delivered by Rocketdyne within two years. Reason for the shortcut: the 1.2-million-lb.-thrust M-1 will be based on technology established during the development of the 200,000-lb. J-2 engine.

Low-level Funding for Dyna-Soar

Dyna-Soar is funded at only $115 million in the Fiscal '63 budget. DOD will oppose industry and AF pressure to increase this. Program was funded at $100 million in FY '62, with DOD rejecting an $85-million Congressional add-on.

IT&T Systems Employed on Mercury Flight

First full-scale test of the new IT&T physiological monitoring console was made at Edwards AFB during the *Friendship 7* orbits. Data on volume, pressure and rate of air breathing, heart beat, G forces, together with body, suit and cabin temperatures were gathered on each pass. Aerospace Data Systems Branch personnel at the AF Flight Test Center are pleased with the results, particularly in light of the system's real-time display, a critical area in the forthcoming *Dyna-Soar* program.

Telstar Satellites in Final Test

First three *Telstar* satellites are in final test phase at Bell Labs' New Jersey facilities. Two of the three are for back up. First launch of the experimental communications satellite has slipped to late May due to a NASA launch schedule shift.

INTERNATIONAL

Australian Radio Mystery

Aid of U.S. satellite programs will be enlisted in an attempt to solve the mystery of a low-frequency radio noise emanating from the Tasman Sea about 200 miles off Australia. Prime suspect as the original source: the sun.

British Find Ultraviolet Sources

Ultraviolet stellar astronomy from British *Skylark* rockets has resulted in discovery of a number of ultraviolet sources, some of which have been identified with early-type stars. These are extremely hot, with an exterior minimum temperature of 20,000°K. Further flights are to be made to distinguish different regions of the UV spectrum.

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Capsules Slimmed for 18 Orbits

McDonnell Aircraft Corp. is "stripping down" the *Mercury* space capsule to prepare it for one-day orbital flights early next year.

The first of four such capsules is scheduled to be delivered to NASA late this year.

Major piece of equipment which will be scrapped is the 75-lb. periscope. NASA officials report that it is not needed and that the pilot can do the necessary visual sighting through the capsule's portholes.

Other equipment which is being removed includes: underwater bombs (used as an aid in determining impact point), one command receiver, backup recovery beacon, backup UHF radio, and one of the two capsule telemetry systems.

Equipment which will be added to give the capsule an 18-orbit capability includes 14 lbs. of batteries, 50% more oxygen and tankage and more water for the cooling system.

When all the shifting is completed, the 18-orbit *Mercury* capsule will weigh slightly less than the 4200-lb. *MA-6* capsule.

Meanwhile, space agency officials are going ahead with preparations for the next U.S. manned orbital flight scheduled for May. The *MA-7* flight with Astronaut Donald K. Slayton at the controls will be a virtual rerun of *MA-6,* with no major changes in the flight plan or the capsule.

Shots of the Week

A *Minuteman* missile was launched from its underground silo March 8 and successfully reached its target 3000 miles down the Atlantic Missile Range. It was the sixth straight success for the solid-fueled ICBM.

In other shots:

- Another classified AF satellite—carrying "a number of classified components" — was launched aboard an *Atlas-Agena B* booster March 7 from Point Arguello, Calif.
- The first flight test of the solid-propellant *Terrier-Asp IV* was made successfully by the Navy from Arguello on March 14.

According to Navy officials, the

launch was a test to evaluate communications techniques between airborne vehicles and ground receiving stations.

• After unsuccessfully trying to launch the first full three-stage *Nike-Zeus* Anti-Missile Missile from the Pacific Missile Range March 8 (see photo), the Army put together back-to-back successes with two *Zeus* missiles launched from White Sands Missile Range, March 13 against simulated ICBM targets.

Bids in for Fire Spacecraft

Eight missile/space firms have submitted bids on the development of NASA's Project *Fire* spacecraft systems.

The firms are Avco, Chance Vought Corp., General Electric Co., Grumman Aircraft Corp., Lockheed Missiles and Space Co., North American Aviation Inc., Republic Aircraft Corp., and Sperry Rand Co.

The high-speed re-entry program calls for development of two spacecraft which will be used to study the re-entry environment for both manned and unmanned capsules returning to the earth at a speed of 24,500 mph.

Dyna-Soar Pilots Chosen

Four Air Force and two NASA pilots have been selected for the *Dyna-Soar* program as "pilot-engineering consultants." A decision will be made later, the AF said, as to whether the six will actually fly the spacecraft.

The four Air Force officers were: Maj. James W. Wood, 37, Pueblo, Colo.; Capt. Henry C. Gordon, 36, Gary, Ind.; Capt. Russell L. Rogers, 33, Phoenix, Ariz.; and Capt. William J. Knight, 32, Mansfield, Ohio.

NASA pilots named were: Neil A. Armstrong, 31, Wapakoneta, Ohio, and Milton O. Thompson, 36, Crookston, Minn.

DOD Outlines Conflict Rules

A directive issued by DOD last week outlined rules of conduct for advisers and consultants.

Implementing the Feb. 9 memorandum issued by President Kennedy, the directive requires the more than 2000 DOD consultants to file a statement of their private employment and financial interests by April 30 of this year.

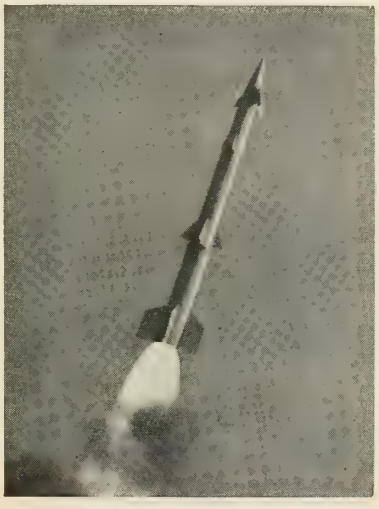
Apollo Fuel Cell Competition

Pratt & Whitney Aircraft Div. of United Aircraft Corp. and TAPCO Div. of Thompson Ramo Wooldridge have been awarded competitive contracts for development of the *Apollo* fuel cell. North American Aviation awarded the multimillion-dollar competitive pact for the fuel cell to insure two different approaches to the design of the all-important internal power supply for the lunar spacecraft.

OSO I Looks Good

Pointing accuracies of NASA's *Orbiting Astronomical Observatory*—launched March 8—are exceeding the expectations of space agency scientists.

Circling the earth every 96.15 minutes, *OSO I* is maintaining an azimuth accuracy of 0.6 minute.



Gone Zeus

NIKE-ZEUS fired from Point Mugu March 8 was destructed when it deviated from its planned trajectory. Test was to have been first three-stage firing from Mugu. Army said some test objectives were met.

QUALITAS
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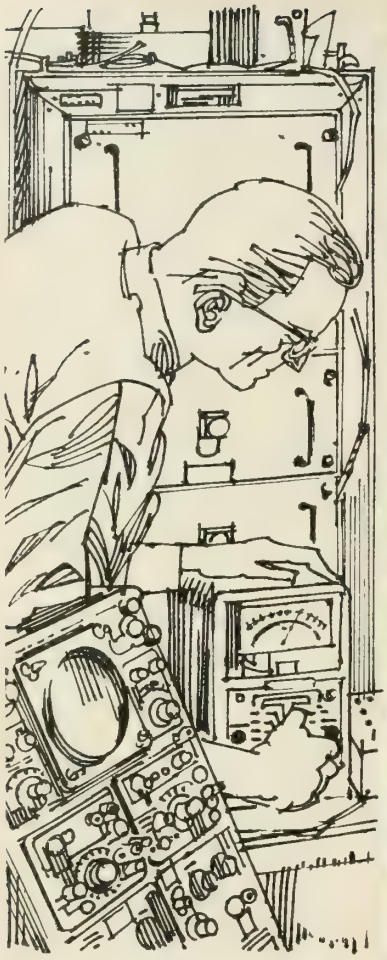

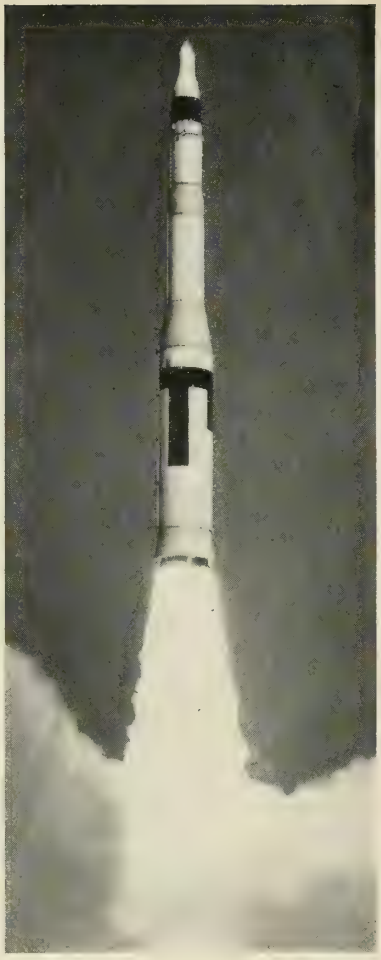

Advanced-program openings at Boeing for

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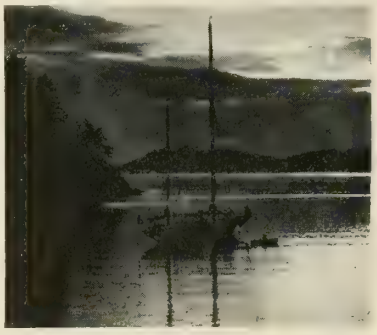
TEST INSTRUMENTATION assignments are available on advanced missile and space programs. Requirements include background in transducer, signal conditioning, as well as airborne-ground telemetry systems development, design and application utilizing the latest state-of-the-art concepts, including PCM/FM techniques.



DATA SYSTEMS engineering openings involve the application of digital techniques to the processing of test data.

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Titan III eases blow . . .

Big Solids Lose Lunar Role

by James Trainor

LARGE SOLID BOOSTERS have been eliminated from even a backup role in the initial manned lunar landing program—despite the belief of many solid-propulsion experts in industry that solids offer the most promising path to the moon.

"Instead of developing the large (solid) propellant engines fully, we propose only to carry on exploration in the large solid-propellant technology," Defense Secretary Robert McNamara told Congress in testimony released last week.

The solids program has been cut back to an advanced technology development effort to be funded at approximately its Fiscal '62 level of $50 million.

Cost of the program as originally proposed would have been on the order of $500 million to $600 million, according to the Secretary of Defense.

While the DOD decision is regarded as a harsh setback for solid-propellant manufacturers, advent of the $500-million *Titan III* program is expected to take up some of the slack.

Citing NASA's decision to modify the original *Apollo* program to include rendezvous, the Defense Secretary officially downgraded the solids to a secondary role in the lunar landing program.

"You may remember that last year in the third budget amendment," McNamara told the House Armed Services Committee, "we asked for authority to begin development of very large solid rocket technology, in part as backup for NASA's liquid-fueled engines, which they were planning to use on a direct flight to the moon."

The decision to use rendezvous for the lunar mission makes it "no longer necessary to have this solid rocket as a backup," McNamara stated.

The decision to proceed slowly with the development of large solid boosters does not reflect a lack of official enthusiasm over the role that solids eventually can play as space boosters.

Officials of both DOD and NASA point out that final decisions on the *Nova* launch vehicle have not been made, and that the first stage of the *Nova* may well use solid propellants. The advanced technology program of DOD—as well as extrapolations from *Titan III*—are expected to provide the necessary data for a decision on the first stage of the 12-million-lb.-thrust booster.

• **Let's do it right**—The primary difference immediately evident between industry and both NASA and DOD is one of emphasis. Industry propulsion experts feel that the feasibility of large solid motors has been proven, and that a development program can safely be initiated to produce multimillion-pound-thrust motors in less than 24 months.

On the other hand, DOD-NASA officials are not sure that the test firings of 100-in. motors under controlled conditions, and extrapolations from *Minuteman* and *Polaris,* can be applied to 13-ft. or 20-ft. class motors.

For this reason, the DOD advanced technology program—worked out last week for FY '63 by a joint DOD-NASA panel—is designed to progress incrementally from the 100-in. and 120-in. motors to the larger-class engines.

"What we don't want to do," one NASA official declared, "is to go into a full development program before we know that the thing will work. This is the quickest way to get into serious trouble." As an example of what might happen with an ill-conceived development program, he cited the ANP (aircraft nuclear propulsion) program, which was cancelled after an investment of over a billion dollars.

This philosophy is echoed by officials in the office of the Defense Director of Research and Engineering, who feel strongly that *Titan III* and limited firings of larger-diameter motors will provide the experience necessary, and reduce the lead time sufficiently, to enable quick and timely application of solid motors to other programs.

• **AF in this, too**—Since the President assigned the development of large solids to the Defense Department—specifically to the Air Force, proposals have gone out to six firms for the *Titan III* 120-in. solid boosters. The proposals were submitted last week and are presently being evaluated.

When this contract is awarded, it will mark the first large development and production contract for large solid boosters. The Air Force has, however, let a $2-million contract to Lockheed Propulsion Co. to build and conduct feasibility tests on four segmented solid rocket motors, each 120 in. in diameter. (M/R, Nov. 13, 1961, p. 28; March 5, 1962, p. 10).

Breakdown of the FY '62 Air Force effort in the solid motor field includes $50 million for large solid boosters, $15 million for solid upper stages and $12 million for construction of facilities. FY '63 expenditures are classified but are put at approximately the same level.

The Air Force presently has under study a large solid booster in the 13-ft. class. This size, according to DOD and AF sources, is the largest practical for military applications since beyond this transportation is restricted to ship, and segment size itself becomes a problem.

In the 20-ft. booster class, according to the Air Force, development would be strictly for NASA missions, since this size also seems impracticable as yet for military use. In building such a booster, however, AF officials appear to favor the monolithic approach due to the difficulty of transporting and assembling a segmented vehicle.

• **Solid problems outlined** — Although enthusiasts claim that the problems of solid-fuel rockets have been solved, both DOD and NASA sources claim that there are still unanswered questions about the ability to control progressive burning, thrust vector control, staging, and the ability of components to survive in the acoustic and vibrational environment generated at launch.

Most of these problems, government officials admit, can be overcome. They cite as a means of doing this the advanced technology program now planned.

More serious, however, is the question of cost/effectiveness of large solid motors. In order to be competitive with liquids, DOD sources say the solid vehicle—since it weighs twice as much—must cost less than half as much as the liquid.

Large solid motors will not be used on the *Advanced Saturn,* according to DDR&E sources. But they most certainly will have application not only for the *Nova* vehicle but also for second-generation *Advanced Saturns* and as building blocks for future space vehicles.

For this reason, both NASA and DOD are actively and, in their view, aggressively, developing the "know-how" for future large solid-propellant motors capable of placing large payloads in orbit. ⌗

At Cape symposium . . .

First Details of ARIS Ships Told

by Charles D. LaFond

PATRICK AFB, FLA.—The "seagoing" Air Force is expected to put the first of two Atlantic Missile Range tracking ships in operation by late this year or early 1963.

Conversion of the World War II troop transports is now in advanced stages of completion at Bethlehem Steel's shipyard in Brooklyn. Installation of the heavy load of electronic instrumentation is under way.

The 14,300-ton, 520-ft.-long vessels will each carry a civilian ship's crew of 100 and an instrumentation group of approximately the same size. Prime contractor for the $70-million AF program, which is aimed at extending the AMR to 10,000 miles, is Sperry Rand Corp.

Visible in the accompanying artist's conception are the optical trackers, telemetry array, two main integrated radar antennas (30-ft. and 40-ft. diameters) and a 30-ft. telemetering dish located aft. It's reported that the main radar antennas are capable of eventual enlargement to 60 ft.

ARTIST'S DRAWING of one of Air Force ARIS (Advanced Range Instrumentation Ships). First converted ship is to be in operation at AMR late this year or early in '63.

ITT Federal Labs is teamed with Sperry on a major portion of the electronics equipment—including telemetry, communications, HF sounder, and timing system.

Data processing on board will be handled by UNIVAC equipment, and a Sperry SINS (Ship Inertial Navigation System) similar to that used

(Continued on page 34)

NASA Seeks $700 Million For Satellites, Lunar Craft

by Hal Taylor

NASA WILL SPEND over $700 million on a series of scientific observatory satellites and lunar exploration spacecraft over the next several years.

NASA officials disclosed the high costs of the space agency's projects before House Space Subcommittee hearings on the FY '63 authorization bill.

All of the vehicles will provide information for Project *Apollo*.

The biggest chunk of funds, $300 million, will be spent on the series of *Surveyor* spacecraft slated for lunar-orbit and lunar soft-landing missions.

Seven *Surveyor A* spacecraft—the lunar soft-landing version — are expected to cost $200 million. The lunar-orbiting *Surveyor B* is scheduled for five missions at a cost of $120 million.

The officials also estimate that a series of "orbiting observatory" satellites will cost $450 million.

The first five launches of the *Orbiting Geophysical Observatory (OGO)* will cost $138 million. Five additional flights are estimated to cost $15 million each.

Three *Orbiting Astronomical Observatories (OAO)* in the 1964-65 period will cost $184 million and $60 million will be spent on the *Orbiting Solar Observatories (OSO)*.

The testimony on the satellite program was given by Homer E. Newell, director of the Office of Space Science, Edgar M. Cortwright, deputy director, and Oren W. Nicks, director of lunar and planetary programs.

Subcommittee members revealed no reluctance to go along with approval of funds for the planned projects. They did indicate, however, that funds for the proposed *Prospector* spacecraft will receive a detailed scrutiny.

The subcommittee chairman, Rep. Joseph E. Karth (D-Minn.) questioned whether the spacecraft is really needed, because its 1966 launch date is close to the projected time for the first manned lunar landings.

The NASA officials indicated that only $10 million will be spent on the program in Fiscal 1963, and that no large amount of funds will be requested until decisions are made as to the mission for the spacecraft.

Karth requested a full report on the program as soon as NASA plans are final—in about four months.

Other important testimony on NASA's Fiscal '63 budget requests before hearings of the four House Space subcommittees included:

• Francis W. Reichelderfer, Weather Bureau Chief, declared that more funds could be used in the research and development leading to an operational meteorological satellite system. "With the funds requested," he said, "there is no room for failures."

He also declared costs of the weather program will level off at a rate of $50 million to $75 million per year. He said President Kennedy has sent Soviet officials a letter requesting that they cooperate in a world weather system. The weather bureau chief said that if

(Continued on page 34)

'For personal dedication'. . .

Gilruth Awarded 1962 Goddard Trophy

ROBERT R. GILRUTH, director of America's successful Project *Mercury* manned space program, has been selected as the 1962 winner of the Dr. Robert H. Goddard Memorial Trophy.

The trophy, presented at the annual Goddard Dinner of the National Rocket Club on March 16, is awarded to the individual or individuals whose accomplishment during the previous year did the most to advance the nation's missile, rocket and spaceflight programs.

The Goddard Trophy Committee selected Gilruth for the award "for personal dedication in leading the Project *Mercury* team which in 1961 achieved suborbital manned space flight and laid the groundwork for the first United States manned orbital flight."

Gilruth, a veteran of 23 years of government service, headed Project *Mercury* from its inception. The program achieved its greatest accomplishment to date on Feb. 20 when the first American astronaut, John Glenn, Jr., made a three-orbit flight around the earth.

An internationally known authority on aeronautical and aerospace research and development, Gilruth already has been tapped for another top job. He will, as director of NASA's Manned Spacecraft Center, head the team charged with the development of the *Apollo* spacecraft.

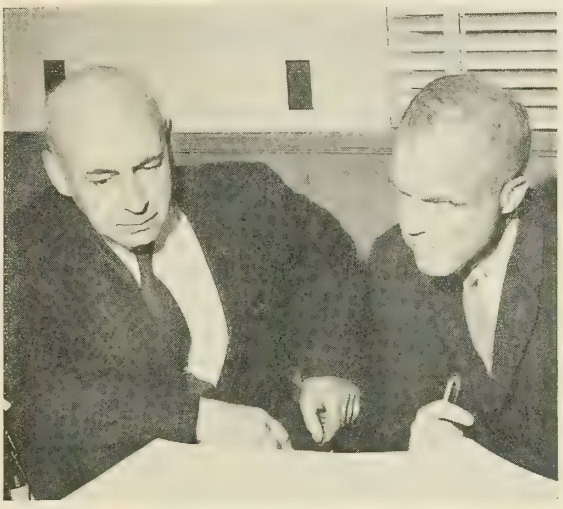
• **Shining roster**—Gilruth joins a list of illustrious previous recipients of the trophy. They include: Dr. Wernher von Braun, Army Ballistic Missile Agency (1958); Sam K. Hoffman, North American Aviation, Rocketdyne Division (1959); Karel J. Bossart, Convair/Astronautics (1960); and Herschel Brown for Lockheed Missiles and Space Company (1961).

Gilruth's selection is a high point in a government service career during which he has won recognition as a national and international authority on aeronautical and aerospace research and technology.

Born October 8, 1913 in Nashawuk, Minn., he graduated from the University of Minnesota with a B.S. degree in Aeronautical Engineering in 1935 and was awarded a Master's degree in the same field in the following year.

In January, 1937, he joined the staff of the National Aeronautical Advisory Committee—predecessor to NASA.

In the early 1940's, Gilruth developed the "wing-flow" method of research, a system which uses the high-speed flow of air above the wing of a diving airplane to investigate high-speed phenomena on small research models. This concept provided information in the transonic regime for new aircraft and missiles. It also filled the gap before transonic wind tunnels and free flight techniques were developed.



MERCURY PROGRAM chief confers with America's first orbiting astronaut, John H. Glenn, Jr., at Langley Center.

This pioneering development of techniques for providing unique data that were otherwise unobtainable continued in Gilruth's direction of rocket model techniques to achieve the capability of obtaining aerodynamic and structural data at speeds of 5, then 10, then 15, and more times the speed of sound; and in his direction of the development of high temperature structural and materials research equipment including such items, as: radiant heaters, ARC-jets, high-temperature wind tunnels, ceramic-heated airjets and others.

• **Fathered Wallops**—In 1945, Gilruth was selected to organize, design and develop the Pilotless Aircraft Research Division which is now the NASA Wallops Island launching site. More than 4500 research models have been rocketed from the station.

For his efforts in the establishment of Wallops Island, Gilruth received the Sylvanus Albert Reed Award for 1950. This award is one of aviation's highest honors and is given annually by the Institute of the Aeronautical Sciences, of which he is a fellow, for notable contributions to aeronautical research.

His success at Wallops Island also brought the Federal government's Superior Accomplishment Award in 1951 and the University of Minnesota Outstanding Award in 1954.

On Nov. 5, 1958, the Manned Space Task Group was set up by NASA at Langley. Gilruth was selected to head it and Project *Mercury*, the first U.S. manned space flight program.

Since its inception in honor of the memory of Dr. Goddard, the father of U.S. rocketry, the trophy has been presented by MISSILES AND ROCKETS. This year, for the first time, Mrs. Goddard is donating the award as a way of expressing her appreciation for the honors bestowed upon her by government and industry in the name of her late husband.

MISSILES AND ROCKETS, however, will continue to handle selection of the winner under the supervision of the National Rocket Club.

The 1962 Goddard Trophy recipient was chosen by a distinguished committee including: August Esenwein, President, Aerospace Industries Association; D. Brainerd Holmes, Director, Manned Space Flight Office, NASA; Vice Adm. W. F. Raborn, Deputy Chief of Naval Operations (Development), U.S. Navy; Gen. Bernard A. Schriever, Commander, Air Force Systems Command, U.S. Air Force; James D. Secrest, Executive Vice President and Secretary, Electronic Industries Association; Lt. Gen. Arthur G. Trudeau, Chief, Research and Development, U.S. Army; Dr. Edward C. Welsh, Executive Secretary, National Aeronautics and Space Council; and William J. Coughlin, Editor, MISSILES AND ROCKETS Magazine (chairman). ⌗

Intensive Ground Tests of Reactor

AEC-NASA officials plan 30-40 firings in Nevada series aimed at producing recoverable reactor and engine for lunar missions

FIRST NUCLEAR ROCKET launch from Cape Canaveral, as upper stage of a *Saturn* vehicle, will be preceded by ground tests of 30 to 40 developmental reactors in the *Kiwi* and *NERVA* programs.

Initial flight, within five years, is expected to involve a design prototype of a recoverable and re-usable reactor and engine. Ground tests are aimed at perfecting such a design. It would eliminate the one-shot booster system currently used with chemical rockets.

The joint Space Nuclear Propulsion Office of the Atomic Energy Commission and NASA has had several name changes under consideration, including a switch from *RIFT* (reactor in-flight test) to *Deimos*, with the follow-on program to be called *Phobos*. (These are the names of the two Martian moons). An SNPO spokesman said: "We just don't like names made up of a bunch of initials from the program."

No specific mention was made of the *NERVA* program (nuclear engine for rocket vehicle applications). There is no connection between SNPO's *Deimos* and the Martin Co. project *Deimos*.

Successful efforts in the flight test program will give impetus to NASA's desire to use the *Advanced Saturn (C-5)* instead of a larger vehicle as the workhorse of the lunar mission program. This objective would require a quickened pace for development of a nuclear engine, but is seen as a preferable route for getting the job done.

• **Safety first**—Safety experts in the SNPO group have estimated that a full-power, full-duration run of the *Deimos* vehicle reactor would generate approximately 0.07 kilotons of energy. The in-flight test would be controlled by a ground command to insure operating safety.

"We will have a small local problem with clean-up if an on-the-pad abort is necessary," the spokesman said, "but only if circumstances should cause the liquid hydrogen propellant to be introduced into the reactor system during the abort.

"If the reactor should fall just offshore and go critical through the introduction of sea water into the reactor system, then we'll have to restrict the nearby beaches for about a week."

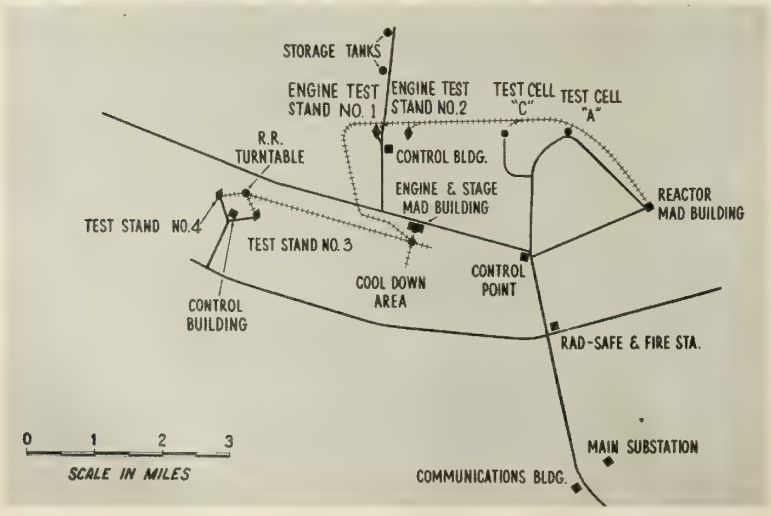
He emphasized that these cases represent the worst conceivable accidents and are extremely unlikely to occur. The contamination problem, however, is the principal reason for not planning a ground-launched nuclear rocket at this time.

Deimos is likely, if present indications remain valid, to have a power of approximately 1000 megawatts, translated into about 50,000 lbs. thrust. Burning time may be as long as 300 seconds, but on first flights will probably be shorter. A 1000-megawatt nuclear rocket is relatively small in size in view on SNPO's overall plans, which include engines up to at least 8000 MW, and possibly 20,000 MW.

(One megawatt of reactor power is roughly equivalent to 50 lbs. of thrust, assuming an I_{sp} of 800 seconds.)

Three contractors have already been selected by NASA to submit final proposals on design and development of the reactor in-flight test vehicle: General Dynamics/Astronautics, Lockheed Missiles and Space Co., and Martin Co. One of these firms will be responsible for the design, fabrication and assembly of the *Deimos* vehicle at the Michoud Operations Plant, conducting components tests and full systems tests.

NERVA will be a direct outgrowth of the *Kiwi-B* series of reactors under development since 1955. The *Kiwi* reactors are being designed and tested by Los Alamos Scientific Laboratory, and the *NERVA* hardware is being designed



MAP OF TEST FACILITIES at AEC's Nevada Test Site. Engine Test Stand No. 1, formerly called Test Cell D, is first downward-firing stand. Others will be built.

cheduled

by Frank G. McGuire

and developed by Aerojet-General Corp., with Westinghouse Electric Corp. as a major subcontractor.

• **Test facilities**—NASA expects to build four test stands for full-scale engine tests, in addition to the two existing test cells at AEC's Nevada Test Site. What has been called Test Cell D at NTS is now designated Engine Test Stand #1, and is the first of the downward-firing stands.

Test cells A and C will continue to be used for reactor research and development.

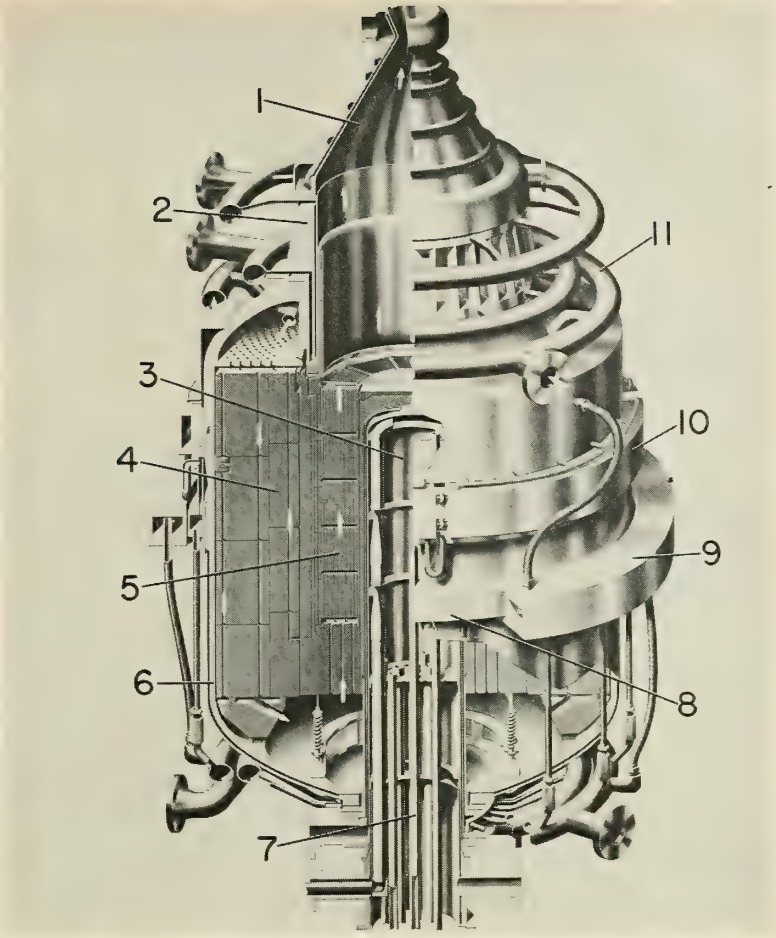
In order to achieve the required 30 to 40 ground tests in time to meet the flight vehicle schedule. SNPO estimates it will need an increased number of stands to offset the inherently inefficient operation of nuclear test facilities.

The nuclear radiation concomitant with reactor/engine tests causes activation of surrounding equipment and structures, greatly slowing the setup and tear-down time of test hardware. Since manual handling is impractical, remote methods must be devised for every step, causing relatively long turn-around times for the test stands.

A test dolly will place the engine in the stand and later remove it, being powered by an electric, remotely-controlled locomotive during these operations. After test, the engine will be taken to the maintenance, assembly and disassembly building (MAD building), while the test stand "cools off."

In the meantime, another engine will be prepared for test and moved into the now-empty stand as soon as practical.

SNPO officials estimate they will need at least two engine test stands to meet the 1966-67 flight schedule for the engine alone. Then in order to test the entire *Deimos* stage, a third stand will be built, and eventually a fourth test stand will be constructed to allow for testing of either the entire stage or the engine alone.



RECENTLY DECLASSIFIED view of Kiwi-A shows how gaseous hydrogen entered system through an entrance plenum (11) flowed downward through a thick graphite deflector (4), through a lower plenum chamber and up through the inlet reflector, then through four courses of uranium-loaded graphite fuel plates (5), with a fifth course of plates acting as a top-end reflector. In the center are the deuterium island (3) and control and scram rods (7). The complex pressure vessel (6) is topped off by the water-cooled, double-walled, small-expansion nickel nozzle built by Rocketdyne. This nozzle was also used on Kiwi-A3, even though slightly radioactive.

The Kiwi-B series of reactors is understood to be using a different core configuration, one utilizing hollow-core hexagonal fuel rods instead of plates. The moderator is believed to be beryllium oxide.

Since the flyable nuclear engine will be used with a chemical first stage and thus only operated at altitude, a special chamber on the test stand will simulate altitude conditions by use of a secondary steam injector in the exhaust duct.

During the 20 sec. required for the reactor to come up to full power, the steam injector system must be instantly responsive to changes in duct pressure in order to provide the correct altitude condition.

• **Cooling off** — Shutdown, a more critical operation, begins with power reduction to about 40%, at which time the reactor will be scrammed. The power level due to heat generated by the decay of fission products within the reactor will fall an additional 30% within five seconds after the reactor is scrammed.

Following this, heat generation for the remaining 10% will fall very slowly, and will take several hours to reach a level where coolant hydrogen can be turned off after having been utilized at reduced flow to cool the heat of fission product decay.

The role of the steam generator at this point in the test cycle is to maintain steam in the exhaust duct until the hydrogen coolant is no longer necessary, inasmuch as the admission of air into the duct from the opening should cause a serious explosion. The coolant itself

(Continued on page 36)

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SR. STRUCTURAL DESIGN ENGINEERS

Responsible for establishing the configuration, structural design and development of re-entry vehicles, missiles and space vehicles including application of new materials, establishment of design allowables and preliminary stress analysis. Requires 8-10 years' airframe structural design with ME or AE. Ⓑ

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Utilize a uniform failure reporting system to determine modes of equipment failure in test and field activities. Conduct failure analysis of significant and/or recurring failures and recommend corrective action. Requires degree plus 3 to 10 years' experience in reliability, test, quality control and design. Ⓒ

INFRARED AND OPTICAL ENGINEERS:

Develops infrared and optical equipment for sensing the presence of planetary bodies and for the sun and its relation to a space vehicle. BS or MS in EE or Physics with 2 or more years of related experience required. Ⓓ

SYSTEMS TEST ENGINEER:

Assigned system is reviewed to assure that performance requirements and specifications are accomplished. Advises design engineering, originates systems test plan and follows qualification and acceptance of the system. EE with 3-10 years of engineering or quality control experience. Ⓕ

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GENERAL ELECTRIC

Ground Support Electronic Systems Engineer

Design and development of ground electronic systems through the RF spectrum for application in the support systems of re-entry or space vehicles. A technical specialist position requiring a BSEE, 6 years experience and a background in such fields as communications, telemetry or radar. Ⓔ

DATA SYSTEMS ENGINEERS
DATA SYSTEMS COMPUTER PROGRAMMERS

Will analyze digital computer requirements of flight and ground test operations with respect to input furnished, output required, and complexity of numerical analysis in the context of a total information system from the transducer to display. Determine, plan, and flow diagram the principal steps, considering real time, near-real time, and delayed time requirements for digital computer processing.

Requires college degree and minimum of 2 years' programming experience with large-scale computers. Should have experience with instrumentation, telemetry, radar, and/or with large information handling systems, including display devices. Ⓖ

PYRO-TECHNICS

This specialist will apply shape charges, explosive bolts, squibs and igniters to in-flight disconnects, ignition of solid propellants and separation action within re-entry and space vehicles. Requires engineering degree and 3-10 years' experience. Ⓗ

OPERATIONAL SYSTEMS ENGINEER FOR SATELLITE PROGRAM

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Operational Command & Control Systems Engineer to assume responsibility for the design, analysis, specification and implementation of operational digital command and control systems for space satellite program. Candidate must be capable of working in system areas encompassing mathematical modeling, data processing, command, logic, satellite vehicle characteristics, mission requirements, display, operational support facilities, operational procedures and systems simulation. Requires BS degree and minimum of 5 years' related experience. Ⓘ

PROFESSIONAL EXPERIENCE (Two most recent or most applicable jobs)

Company_____ Position _____

Years of experience (from)_____ (to)_____ Salary_____ Assigned Duties _____

Company_____ Position_____

Years of experience (from)_____ (to)_____ Salary_____ Assigned Duties _____

PERSONAL DETAILS Name_____

Home Address _____ City_____

State_____ Telephone_____ U.S. Citizen Yes ☐ No ☐

Education

Undergraduate College _____ Degree _____ Year of Graduation _____

Graduate College _____ Degree _____ Year of Graduation _____

Position Objective (primary job preference, level of responsibility, salary expectations) _____

I am interested in the following position(s)

Space Power & Propulsion	A
Vehicle Engineering	B
Reliability	C
IR & Optics	D
Ground & Space Support	E
Systems Testing	F
Digital Programming Analysis	G
Pyrotechnics	H
Systems Engineering	I

Simply circle the appropriate letters of those positions that meet your professional interests and qualifications, fill in the questions to the left—attach a resume if you have one handy—and airmail to:

Mr. Frank Wendt, Div. 486-L
Missile & Space Vehicle Department
General Electric Company
3198 Chestnut Street
Philadelphia 4, Pennsylvania

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Technical Countdown

ASW ENGINEERING

Extensive Sonar Net Under Study

The Navy apparently is showing intense interest in a detection plan calling for seeding the ocean bottom with radioisotope-powered sound sources whose emanations would be picked up by ocean-surface buoys and radioed to searching aircraft. Crux of the plan is that if the pattern of emanations is altered in a significant way, enemy high-performance subs might be detected and located. A long-time proponent is Martin Co.'s Systems and Products Div., which just received a $600,000 design contract from Bureau of Weapons for such a system.

SUPPORT EQUIPMENT

Universal Checkout Pact Awarded RCA

A little-heralded contract award by the Army to RCA may have a profound impact on checkout systems for future Army missile systems. The contract, for about $1.5 million, calls for RCA to develop and build universal checkout systems for ten Army missile systems. Northrop's Nortronics division had been a leading contender for the checkout contract. Work will be done at RCA's Moorestown, N.J., plant.

OPTICS

Laser Research Still Pumped High

Twenty-two papers on optical masers were presented in Washington last week at the four-day Spring Meeting of the Optical Society of America. Included were descriptions of two highly advanced concepts for optical pumping—one making use of the intrinsic conversion efficiency of phosphors for "cathodoluminescent" pumping; the other suggesting the use of exploding bridgewire for pulsed-laser operation. Both approaches were based on advanced research by Westinghouse-Baltimore. Four papers each were presented by scientists of Westinghouse and American Optical Co., further emphasizing the marriage of the optics and electronics industries through laser technology.

Unique UV Lens Developed

An unusual new lens for ultraviolet application using lithium-floride elements and fused silica (for negative color correction) has been developed by Barnes Engineering Co. Spectral transmission range is from 5200-2000 Angstroms. Other characteristics, Barnes reports, include 40° field of view, resolution to better than 20 lines/mm, focal ratio of 3.3 and focal length of 105 mm. Color balance is described as good, with no vignetting, and the image focuses in a flat plane. The lens is expected to find wide use in space studies and meteorology.

ELECTRONICS

New Memory Circuit Successful

A cryogenic associative memory circuit has been developed by GE's Heavy Military Electronics Department. Believed to be the first operative circuit of its kind, it could significantly simplify design requirements for high-speed, large-storage-capacity computer memories. The thin-film developmental circuits measure 3x6x0.05 in. Test data indicate that the units would permit a 300,000-bit memory search (to locate a first idea association) in about 50 microseconds. Liquid helium is used as the coolant.

Big Business for Phase Arrays?

Sperry Gyroscope Company believes its several-year investment in phase array work will soon pay off with a high-volume surveillance and tracking business. It claims that it can use this technique to build a radar system that will constantly observe "several thousand basketball-sized objects at distances well beyond the earth's atmosphere." Phase array is an ultrafast electronic scanning technique which eliminates the need for a moving antenna.

DSIF to Get S-Band Radars

Jet Propulsion Lab's DSIF (Deep Space Instrumentation Facility) will be updated soon with the addition of an S-band radar capability. Motorola will build and install the equipment at all three of the global stations (Goldstone, Woomera, Johannesburg). The $1-million contract calls for a three-channel tracking receiver and separate listening sum channel and Doppler extractor at each site. The system is expected to increase accuracy of range measurements of deep space probes and generally improve long-range space communications.

Compact BUIC Sought

New back-up for SAGE will be the BUIC system (Back-Up Interceptor Control). The Air Force Systems Command's Electronic Systems Division, Hanscom Field, has sent out requests for letters of interest from industry; returns are due March 22. BUIC is expected to provide an emergency means for controlling all weapons under the North American Air Defense Command. The present 416L SAGE System Program Office will direct the new program. Essentially a solid-state computer/data processing system, it will provide weapons control insurance during a post-attack period.

PROPULSION

Ocean-Recovered Engines Usable

A series of dunking tests with an H-1 *(Saturn)* engine has proven the economic feasibility of reclaiming ocean-buried engines. Marshall Space Flight Center engineers revamped an unprotected, dunked, H-1 engine, fired it successfully—and figured the total cost including parts, man-hours and transportation at 10% of the new engine price. The next big snag is in perfecting a let-down system to prevent engines from burning up as they re-enter or being damaged by water impact.

ADVANCED MATERIALS

Friction in Journal Bearings Studied

Friction problems which result in the malfunctioning of dynamically loaded journal bearings are being investigated by Cornell University scientists under a National Science Foundation grant. Professors F. W. Ocvirk and J. F. Booker are aiming for theories which will permit efficient and reliable designs. Turbine and reciprocating machinery are involved, as are both digital and analog computations.

Silicone Fluid Promising as Coolant

A NEW, LOW-VOLATILE, extreme temperature silicone fluid for coolant applications in advanced airborne electronics equipment has been perfected by Silicone Products Dept., General Electric Co.

Its electrical properties are similar to those of polymethylsiloxane liquids. The crucial difference is that the low-temperature volatiles have been eliminated through a new GE process.

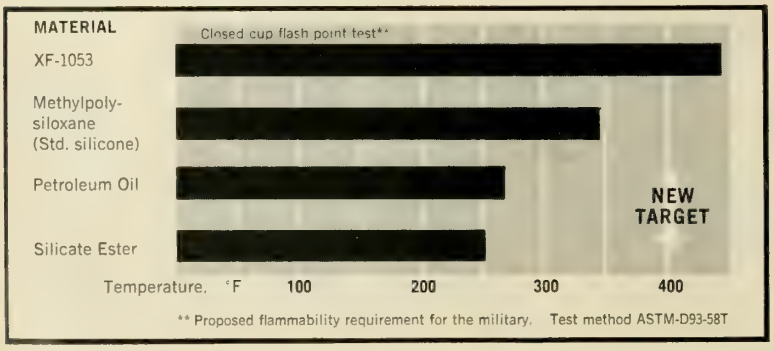
This devolatilization fractionation provides a fluid with high flash point and low evaporative characteristics. Designated XF 1053, it possesses viscosities as low as 140 centistokes at −80°F. The Air Force target at this temperature is 200 (Max) centistokes.

XF 1053 is the only fluid available meeting the new closed cup flammability tests being considered by the Air Force, and proposed AF requirements for an electronic coolant in the silicone temperature range to replace organic fluids.

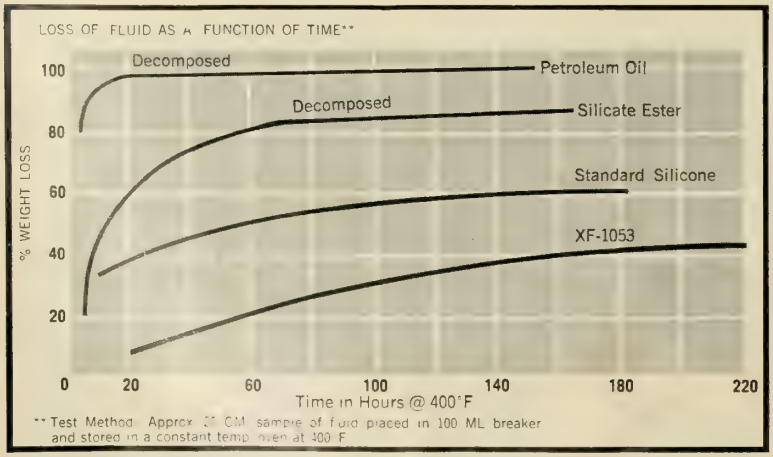
In general, the properties of XF 1053 include:

- Closed-cup flash point greater than 400°F, far greater than conventional coolant materials.
- Low weight losses at high temperature—up to three times less than present conventional materials.
- Low viscosity/temperature coefficient—Minimum viscosity change over wide temperature range.

In additional thermal stability studies conducted by the Air Force, the fluid has exhibited negligible degradation at 600°F.



CLOSED-CUP flashpoint tests show XF-1053 dielectric coolant exceeded proposed AF target requirements. Standard silicones proved better than other contenders.



WEIGHT LOSS of XF-1053 reached only 20% at 60 hrs.; silicate ester decomposed completely. Fluid had lowest evaporation-weight loss of all contenders.

- **Far ahead**—As illustrated in the comparison data in the weight loss tests, both petroleum oil and the silicate ester fluids experienced oxidation and complete decomposition after a relatively short time. The oil left a brown sludge after 10 hours at 400°F, the ester changed to hard crystals after 80 hours at the same temperature.

No evidence of material gelation and oxidation was found in the XF 1053 fluid after 160- and 220-hour examinations. This is in line with the capabilities of the best standard grades of silicones. In previous thermal and oxidative stability studies, these have shown useful lives of about 1000 hours at 392°F and about 200 hours at 482°F.

Since the basic structure of the XF-1053 fluid is methypolysiloxane, it possesses the usual good insulation properties. This combination of fluid properties with an insulating liquid offers the dual advantage of increasing both the dielectric strength and the heat dissipation characteristics of an electronic assembly.

The initial cost to the user is $12 per lb., but some of the fluids it replaces cost twice this. There is also the real possibility that many different grades of stocks can be done away with with the substitution of XF 1053. Price reductions can be expected as volume increases.

- **Vacuum/hydraulic potential**—While GE scientists consider XF 1053 a significant contribution in its own right, they believe the potential of the new low-volatile silicone type it represents is huge.

The principles of fluids for high temperature and vacuum service could have further interesting implications when applied to some of the higher temperature silicones under development.

No electronic system now in operation requires a 650°F coolant with low volatile fluid capabilities, but future needs in this area as well as in lubricants and hydraulic fluids may well be served through further development of this technology.

Electronic gear for some of the presently planned space programs will increase in complexity; as this occurs, heat build-up can be anticipated. One expected application is in the *Apollo* capsule. ⁂

He solved this puzzle by taking it apart!

Like oil and water, extreme precision and "complete" mobility resist combination in tracking radar antennas. Designing for one of these characteristics "automatically" precludes the other. *That* was this AMF Engineer's puzzle—to put *both* precision *and* mobility in an antenna for duty with the Marine Corps.

He solved the puzzle, literally, by taking apart the solution—AMF's TPQ-10 antenna—into 10 rugged, portable, submersible, precision-fabricated packages. TPQ-10 is designed for helicopter transport. Each component can be dropped in water; it will come up for more. The packaged antenna on its pallet can be dropped on land from 3 feet without impairing precision.

Each component can be *picked* up—the largest weighs 425 lbs.—and can be handled by 3 men. A crew of 6 can put TPQ-10 together in 20 minutes with one standard wrench.

Among the design innovations that solved the puzzle is a "piggyback" gear arrangement that puts both azimuth and elevation drives in one package. Result: almost half the parts and weight of separate components. Precision fabrication is typified by the reflector arms, held to a .005" deviation over 45 inches!

(For unclassified information on early warning and radar antenna systems, write Dept. CS 1, address below.)

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- **Manager—Product Processing Section** . . . Propellant and motor component processing engineer with responsibility for providing leadership in tasks of planning and directing processing of propellant formulations and motor components for use in rocket motor development programs. Direct motor finishing operations and final assembly.

- **Manager—Advanced Products Section** . . . Responsible for initiating new concepts and ideas on propulsion devices. Direct preliminary design of new propulsion systems. Synthesize and analyze system operating problems. Aid in market surveys for planning future work areas.

- **Manager of Test Operations** . . . To direct staff of Project Test Engineers in planning and performing solid rocket development test programs. Develop and operate facilities for testing motors, propellants, explosives and environmental testing. Will plan programs, define instrumentation requirements, design and direct test set-ups.

- **Senior Reliability Engineer** . . . To develop project reliability assurance plans. To provide design coverage for reliability prediction and assurance. To plan reliability test programs. Also to plan controls for production of rocket motors and components.

- **Design Engineers** . . . To design structural components for rocket motors and associated equipment, specify materials for construction. Recommend methods for construction or fabrication of design items. Calculate stresses, strains, heat transfer, vibration and dynamic loading effects.

- **Project Test Engineers** . . . To plan test programs for projects, coordinate all instrumentation and test plans, designs and operations. Represents test function in project organization for development of rocket motors, propellants, explosives or explosive devices.

- **Physical Test Engineers** . . . To perform and direct material tests and non-destructive tests on propellants, explosives and rocket motor materials. Plan and perform programs of physical tests for propellants and explosives under development, advise designers on grain design and material capabilities. Knowledge of radiography and ultrasonic methods desirable.

- **Internal Ballisticians** . . . To make charge design studies to optimize ballistic performance and preliminary charge design studies for proposals. Make ballistic calculations of the parameters on propulsion units. Experienced in ballistic evaluation and analysis of propellants and propulsion systems.

- **Mathematician—Statistician** . . . Supervise data reduction and mathematical services function and provide advisory services in mathematical analysis, design of experiments and statistical analysis. Reduce data from propulsion and explosive tests.

- **Propellant Process Engineers** . . . To plan and direct processing of propellant formulation and motor components for use in rocket motor development programs. Direct motor finishing operations and final assembly.

- **Product Development Engineers** . . . To coordinate and carry out tasks of integrating components into complete workable systems and to record characteristics and performance of such systems. Prepare development plans including test objectives and schedules.

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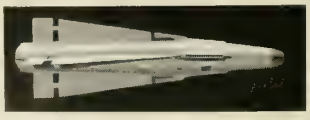
Advanced TWT Research and Development
Solid State Computers



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Life Support 'Know-How' Updated

by Heather M. David

FIRST RESULTS of a $300,000 study of environmental control requirements for space vehicles have been released by the Aeronautical Systems Division, Air Force Systems Command.

The report—a veritable "how to" for life support engineering for manned space vehicles—was prepared by North American Aviation's Los Angeles Division and AiResearch Mfg. Co.

The program is analytical and experimental. The researchers are determining the state of the art, evaluating it and developing the best approaches. Hypothetical vehicles incorporating the results of the study have been carried through preliminary design and used as thermal and atmospheric control models.

• **First approach**—Arthur R. K. Breeze of North American says that the designer must first know 1), environmental requirements of the equipment and 2), physiological requirements of the men who will make up the crew. He cautions that average numbers for performance and metabolic activity cannot always be relied upon because man's emotional and physical states affect his sensory ability.

Some tables which should be very helpful to design engineers are: 1) methods of computing man's oxygen requirement and carbon dioxide output based on nutritional requirements; 2) equations for computing human heat losses and cabin decompression rates, and their use in establishing thermal and atmospheric control systems; 3) recommendations for additional study efforts to develop a simple mathematical model of a man as a basis for the development of optimum cabin atmospheric composition, thermal conditions and sustenance support; 4) other physiological and metabolic data organized in a form readily usable by the systems engineer for establishing requirements for thermal and atmospheric control systems.

Points of interest:

—Short-duration missions will present more problems in estimating human requirements due to emotion and stress. On longer missions, a percentage can be arrived at.

Compartment volume requirements per man are much less for short missions than for voyages of more than one or two days. In addition, if a pressure suit is worn all the time, it cuts down the man's space by about 2 cu. ft.

—Long-duration missions will be problematic in design of atmospheric composition control and thermal comfort control. The shirtsleeve environment is best, as is the gas composition of air at sea-level conditions.

At the present state of the art, the oxygen-rich 30-40% atmosphere (10-11 psia) with a diluent gas is best.

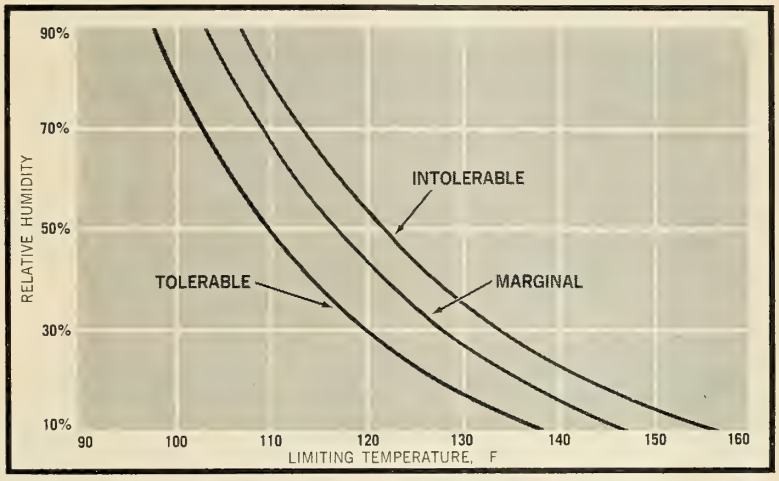
Another advantage of the air mixture is that if there were a cabin leakage, the astronauts could have as much as a half-hour more time to find and repair it than they would in a 3.5-psia, 100%-oxygen atmosphere.

—The maximum concentration of CO_2 for long flight periods is 0.5% by volume.

—Temperatures must be closely kept to within 65 to 73°F range for long-duration missions. The report has excellent charts and diagrams on the thermal properties of different components, subsystems and men at various tasks.

—Re-entry temperatures must be kept to under 200°F in the cabin if re-entry is to take a half-hour or more. Emergency heat situations of more than 200°F must not last longer than a half-hour.

—In a normal temperature situation (70 to 80°F) a man can survive for about 10 days without water provided he starts with a normal water balance.



GRAPH OF tolerable, marginal and intolerable limits of temperature and humidity.

• **Further facts needed**—The report is the result of the first six months of a three-year study. Breeze pointed out that further study is needed on:

—More data on man's reaction to prolonged exposure to various artificial atmospheres.

—Determination of realistic water requirements.

—Production rate of contaminants as a function of time by the equipment and materials carried in the vehicle.

—Concepts of escape for application to orbital and cislunar vehicles.

—Studies of drugs and other pharmaceuticals which might increase man's tolerance to stress and their possible toxicity.

—Physiological data on man's tolerance to transient changes in his thermal environment.

The report even covers the effect of crew illness upon the space cabin environmental system. Diseases producing fevers will increase the speed of chemical reactions within the cells, raise the body temperature and metabolism. Diseases with chills also raise the metabolic rate because of the increased involuntary muscular activity. This would cause increased use of the crews' stores of oxygen, but should not be too big a problem, since emergency stores would be figured in for other reasons.

Copies of the report are available from the Office of Technical Services and the Armed Services Technical Information Agency (ASTIA). ⌗

STL Drives for Hardware Business

Firm forfeited heavily when it broke with Air Force, but has confidence based on new awards

by Willard E. Wilks

STL'S METTLER—*With $25-30-million investment in FIT, "we have the confidence our bankers must have."*

EL SEGUNDO, CALIF.—Space Technology Laboratories, free of the restrictions created by its former relationship with the Air Force, now is driving hard to become a major contender in the space hardware business.

Company officials have found that the change requires a whole new management approach.

"We get a certain lump in our throat," the new, 38-year-old president of STL told MISSILES AND ROCKETS recently. "We've put our neck on the line."

Dr. Ruben F. Mettler can't be blamed for some preoccupation with STL's neck, for the Thompson Ramo Wooldridge subsidiary's two-phase building program, now half-completed, represents a $25-30 million bet that it can "make a major, concrete step into the space hardware business."

Mettler is confident, however.

"The best way I can characterize it is that we, ourselves, have the confidence that our bankers (including TRW) must have," he says. "We are making this as a corporate investment with all private money. We are not asking the government for funds."

Completed so far are five of 10 new buildings in STL's plan, including a five-story engineering office building, three two-story research buildings, and the Fabrication, Integration and Test facility (FIT). (See p. 32). Focus of STL's hope is the FIT building, designed to provide "the technological capacity to do anything that needs doing in the spacecraft field."

• **Making the break**—STL's confidence is based on the business it has picked up in the 20 months since July, 1960, when, as TRW vice chairman Dr. Simon Ramo put it, "STL severed its

special relationship with the Air Force and became a conventional, competitive contractor."

That relationship, which prevented STL from obtaining major ballistic missile hardware business, had been started in 1954 when the former Guided Missiles Research division of Ramo-Wooldridge Corp. won the job of providing systems engineering and technical direction for the Air Force ballistic missile program. In July, 1960, the new nonprofit Aerospace Corp. took over three jobs STL had been doing for the Air Force:

—Advanced planning for future systems.

—Technical staff assistance.

—Administrative and "housekeeping" support, including provision of some Air Force housing, a car pool, building maintenance, and office services, all of which comprised 15-25% of STL's activity.

STL retained the SE/TD work on *Atlas, Titan* and *Minuteman* "as a normal industrial contractor."

While the programs remaining to be completed left STL with substantial revenues, the switch brought dire industry predictions regarding the firm's future—some not without malice. As one industry executive put it: "There were contractors who had felt that they could do systems engineering on their own programs just as well as STL."

On STL's books, the switch meant that "in one stroke we lost one-quarter of our business," Mettler says. It also meant a growing loss of business unless STL started winning new work immediately. For while STL was left with a total contract effort of about $60 million a year, more than half of that was missile work due to run out in several years.

"Overnight we were faced with a variety of unusual problems," Mettler says, pointing out that in the missile business STL is "unique in what it has *not* done."

Under its Air Force contract, STL had been limited to a strictly "no hardware" role in the missile program, except for a few special situations requiring approval of the Air Force Secretary. Because of the enormous scope of the program, and because it was such an absorbing responsibility, the company sought relatively little additional business. STL built *Pioneers I* and *V* and *Explorer VI*, but these programs called for very little hardware.

• **Gains with pains**—In July, 1960, this all boiled down to a prospect that few big, going concerns have had to face:

"We were a company that had not been in the competitive arena," Mettler says. "We had no sales offices, no sales organization at all. We had relatively few contracts."

But the change in status had accomplished several things both STL and TRW felt improved their competitive position:

—STL was now free to get into the fabrication business, where, Ramo says, "you get more return on your investment."

—STL got out of the business of providing administrative, housing and "housekeeping" support for the Air Force. "We were really pushing to get rid of that," Ramo said.

—Most important, TRW felt it had gotten rid of a "Jonah," which STL had become because of its special relationship with the Air Force.

In 1958, STL was incorporated as a separate and autonomous company, with the provision that it give its parent financial but no operational information, the intent being to avoid providing any information which might be construed as giving TRW a competitive advantage. Nevertheless, the feeling persisted in the business that STL was in a position to feed such information to TRW.

Moreover, Ramo says, there was a misconception about STL "that hurt TRW business—people had come to think that the Air Force 'owned' STL. In Washington, someone looking over a TRW bid would say, 'Oh, yes, they run STL—isn't that a government outfit?' "

• **Regrowing**—STL's first goal following the switch was to "grow back to where we were before." In the ensuing months of planning, reorganization, staff expansion, building of new facilities and creation of a sales organization, it has done that and a bit more.

"In passing from the year 1961 to 1962, our work rate reached roughly $82 million a year," Mettler says. "For the year 1962, about one-half of our effort will be continuation of our work on ballistic missiles. The other half will be new work on contracts competed for and won since July, 1960.

"In general, we feel we have tested ourselves in the competitive arena. We have won the prime contracts on *OGO* and *Vela Hotel*. These are the major ones. We competed for *Surveyor* and lost, and we competed as a team with General Electric, Douglas and Grumman for *Apollo*, but lost there, too. We competed for and won the contract for systems engineering services for the Army *Advent* Management Agency. So we have won some and lost some. On the balance, the net result is one that we are very pleased with."

STL currently has 95 military and non-military contracts, and expects business to hit $100 million within the next year, if the present growth rate continues. Contracts won since July, 1960, include:

Prime on *Vela Hotel*, a multimillion-dollar award; prime on *OGO*, about $23.5 million; systems engineering participation in the *Nike-Zeus* target program (BSD), $4.9 million; production of broadband power amplifiers, (sub to Sanders Associates) $4.5 million; research on advanced space-based interceptors (Air Force) $1.2 million; the range and range rate tracking system for Syncom (NASA) $1.3 million; others, ranging from $19,000 to $600,000, include post-*Saturn* space vehicle study (NASA); study of non-linear techniques for space vehicle control systems (AF); study of PRIMAG (Printed Circuit and Magnetic Recording) for sonar use (Navy); advanced data processing system for use in connection with Project Artemis (Hudson Labs); radiation determination modules for ARENTS (Convair); ground readout equipment (AF); study of use of electronic device for generating electromagnetic radiation (AF); ion beam study (NASA); research on *Saturn*- and *Nova*-class vehicles (NASA); particle acceleration study (AF); study of payload capabilities of current U.S. medium class space vehicles (NASA). STL also is working on *Relay* and *Ranger*.

• **Not in tank business**—"In seeking new business," Mettler says, "we are focused heavily on spacecraft and associated support equipment. We are not competing to build large tanks or boosters." Overall, he expects STL, with its extensive systems engineering experience, "to continue leadership in the space technology and ballistic missile fields."

Mettler sees the $7-million, 133,000-sq.-ft. FIT building, which consolidates STL's old scattered hardware facilities and doubles capacity, as enabling the firm to "really go after more hardware business. We've poured all of our experience into making it the best there is. Spacecraft will be produced in very low quantities, each a different, short-run item. That is the nature of the business, and we have tailored the facility and our procedures to that end."

In the *OGO* program, for example, the production rate will be two or three

STL's Huge 'FIT' Building Is Ultimate in Integration

EL SEGUNDO, CALIF.—The 133,000-sq.-ft. Fabrication, Integration and Test building (FIT) is a key unit in STL's 10-building, 110-acre tract here.

The FIT building has been geared, from basic design concepts through completion and equipment fitting, to the establishment of a completely integrated facility for development, fabrication and test of space systems.

Production facilities also are available in the FIT building, not for mass industrial use but for the specialized equipment and capability needed to backup STL's space programs.

One of the most important tools for the firm's space projects will be a new 30-ft. spherical space simulator now under construction by Chicago Bridge and Iron at a cost of $500,000. The simulator will be able to handle test articles 19 ft. in height or width—the size of the access door. If a test article can be dismantled for work in the chamber, there is a 28-ft. clear interior working space available.

The simulator will cover temperatures ranging from +275°F to −325°F and atmospheric environments down to 1 x 10^{-6} mm of Hg with a spacecraft such as OGO in the chamber. It also has capacity for expansion to lower densities with the addition of pumps. The side door may also be used, with modification, as an air lock. An extension can be added to the door area if it is necessary to expose long, slender articles to the space environment.

The space simulator will also have solar simulation capability, including simulation of how the sun would look from Venus. This unit was designed and built by STL. It uses carbon arc light sources because of the spectral match with actual conditions as compared to other available light sources.

All test articles for the sphere will be attached to the cover. This allows complete checkout of all systems prior to chamber testing. It also permits all cabling and other instrumentation leads to be centralized in a single access and pass-through area.

The big sphere will be located at one end of the FIT building's high bay—40 ft. wide, 50 ft. high, and 400 ft. long. The entire bay is serviced by a 10-ton overhead crane.

Second major spacecraft facility in the high bay is the systems integration and test area—about 17,000 sq. ft. In this area, spacecraft such as OGO, EGO and POGO or that for Vela Hotel will be completely checked out many times before they are ready for delivery. All checkout equipment to be used will be portable, to provide flexibility in placement of spacecraft checkout stations.

Integration of the systems here will be about as complete as it is possible to achieve. STL plans to duplicate all spacecraft functions "hundreds of times at a distance of 100 ft. rather than 100,000,000 miles." A control room is provided in the high-bay balcony for test data recordings. In addition, service tunnels connect cabling and other instrumentation to test vans which may be located outside the building.

Third area in the high bay is the structural test facility—a 9500-sq.ft. laboratory, which includes offices and mechanical and electronic support areas. Key fixtures: a 28 x 60 ft. load reacting test floor, a 10 x 10 x 12 ft. universal test fixture, and a 16-ft. nose fairing test stand. A 2000-KVA radiant heating facility will also be added.

spacecraft a year. Mettler estimates R&D, fabrication and flight operations up through the first three *OGO* flights will run more than $20 million.

• **Two-part overhaul** — STL has undergone what VP-Corporate Secretary Fred Hesse calls a "two-phase reorientation of organization" in readying itself for its new role as a TRW competitive division. In place of its old R&D and Advanced Planning divisions are five operating divisions—Fabrication, Integration and Test, Physical Research, Systems Research and Analysis, Mechanics, and Electronics. Management is organized in three areas—Ballistic Missile Program, Defense Systems Program and Space Systems Program.

Occupying a special niche in STL's organization chart is the Products Division, which, Mettler says, has "begun some modest commercial sales" of products, including an image converter camera and a rubidium frequency standard.

In helping the Air Force to establish Aerospace Corp., STL employment dropped to some 3500 from about 5000. Today, employment is back up to around 4800, including 1800 scientists and engineers.

• **'Fat' more apparent than real**—TRW executives feel that in some ways it was "an unfortunate experience for the firm to be a principal contractor in the biggest program of its period." For one thing, there was the feeling among industry that a fee rate of 14.3% for its Air Force engineering work made STL a rather "fat cat" compared to the hardware-producing firms. But Ramo points out that this fee was cut to 9.3% of estimated costs.

Furthermore, Ramo says, the hardware maker realizes a greater return on investment "because when you are in the engineering business, you don't have the government providing half of the facilities. You provide your own. When you are in fabrication, the government provides, on the average, half of the facility."

Dr. Louis G. Dunn, until recently STL president and now chairman of the board, once testified before a subcommittee of the House Committee on Government Operations that major airframe and missile production contractors averaged 19% return on their capital while R-W profits under its Air Force fees at one time meant STL's return "would be less than 13%."

Dunn also pointed out that "contrary to the normal situation, where contractors receive facilities from the government, we provide these facilities . . . we are not aware of any other government contractor which is in a similar negative government facilities position."

• **Transitions**—Ramo sees a continuing "transition from the old pattern of government procurement in which a single contractor handled an entire project. Today, there is accelerated development, new technologies are being used more than before. And projects are bigger and based on recent scientific development. You simply cannot put out a single contract to a single company."

The overall effect of this and the fact that space vehicles are not produced in great numbers is that aerospace companies which formerly were "heavy on fabrication and production, and light on engineering are changing," Ramo says. "There is heavier emphasis on engineering."

On the other hand, engineering-oriented firms such as STL are moving more in the direction of fabrication.

"These companies are changing their mix," Ramo said. "We're all beginning to look more alike."

The capabilities of STL are complemented by those of other members of the TRW corporate family, which has nearly 60 years of mass precision manufacturing experience. In addition to STL, other TRW operating groups include: Tapco Division (jet engine components, fuel pumps, solar and electrical power supplies, and the M-14 rifle); Automotive Group (valve, piston rings, steering linkages and other components); R-W Division (computer systems and advanced hardware); and TRW Electronics (transistors, diodes, capacitors, and other electronic devices).

TRW's international operations extend these skills and technologies to include a network of arrangements with 11 different companies in foreign countries. ⌘

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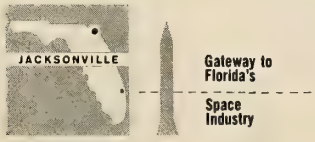

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Range Symposium

(Continued from page 14)

aboard *Polaris*-carrying submarines will supply ship's position information. A complete meteorological station also will be carried on board the tracking ships.

• **Range symposium jammed**—Details of the new AMR tracking ships, other advanced instrumentation, and range problems were described at the recent Range Instrumentation Symposium here.

Expecting roughly 600 persons to attend the three-day meeting, Air Force officials were pressed to find facilities to contain the estimated 900 who poured in from all over the country.

Sponsored jointly by the AF Missile Test Center and the Cape Canaveral Chapter of the Armed Forces Communications-Electronics Association, the symposium sought to examine future trends in range instrumentation and testing.

Indicative of future growth at AFMTC was the prediction by Air Force officials that the AMR capital investment will grow from its present $1 billion to over $2 billion in the next 2 years.

While a majority of this investment will be for new NASA/AF construction, a considerable amount of new range instrumentation will be required, officials asserted.

Over the next 5-10 years, the two programs which probably will require the greatest total amount of money will be the tracking ships and range-support satellites, which are now being considered.

• **ARIS expansion**—First details of the AMR tracking ship program were obtained by M/R editors last week from government and industry officials.

As currently conceived, the Advanced Range Instrumentation Ships program (previously called MARS for Mid-Atlantic Range Stations) calls for 10 ships.

The first two ship conversions and instrumenting will be managed by Sperry Rand. The existing program is funded at $70 million, based on the recently definitized contract. (To date, Sperry has performed on a letter contract only.)

Now two-thirds completed, the first vessel is due for completion by the end of September; the second should be finished 45 days later. Both should be operational late this year or early in 1963. A PERT-type management structure and control have already been established.

A request for funding of ships 3 and 4 are included in the FY '63 AF budget.

Ships 5 and 6 will be similar to the first four but will be instrumented to support the advanced penetration aids program. This involves support for both the AF ICBM and Army A-ICBM developmental program.

Overall, ships 1 through 6 will be considered master ships; 7-10 will be satellite or support vessels. The master ships will carry C-band radars; complete telemetry, communications, meteorological, and control center systems; stabilization and navigation systems; plus AMR-synchronized timing equipment and vehicle command control systems.

The master ships will carry continuous-wave transmitters; the support ships will have L, C, and X-band radars and range and range-rate systems but will not have operational control centers.

• **Glotrac operational soon**—Another new AMR system due for completion soon is Glotrac. A global tracking system being built by General Dynamics/Astronautics, it is intended primarily for early use with the *Centaur* and *Advent* programs.

Initially six or seven air transportable stations will be employed to provide improved accuracy in position and velocity measurements over very long distances. ⠿

NASA Budget Hearings

(Continued from page 14)

the Russians would set up a ground receiving station in that nation it would immeasurably improve the systems coverage.

"Recent correspondence," he continued, "indicates they might cooperate."

• Both NASA's *Surveyor* and the Army's *Advent* program have been delayed because of the slippage in the *Centaur* launch vehicle program. In addition, NASA lost several million dollars when it was forced to scrap certain equipment to reduce the size of the *Mariner* spacecraft—also because of *Centaur's* unavailability.

Rep. Karth told the NASA officials that "you better build a few more *Surveyor* spacecraft, because *Centaur's* performance is a little 'iffy'."

• Associate Administrator Robert C. Seamans, Jr., declared that NASA "welcomes the National Space Council's advice on overall policy matters, but they are not a board of directors reviewing our projects in a detailed way."

• Harold B. Finger, director of NASA's nuclear propulsion office, said that the development of materials that could operate with liquid metals and metals vapors up to 2000 or 2500°F would be the biggest single technological advance in nuclear propulsion.

He confirmed that the reactor testing program for the *Nerva* nuclear rocket engine is three months behind schedule. He also said that sea launch sites are not needed for safe launch of nuclear upper stages.

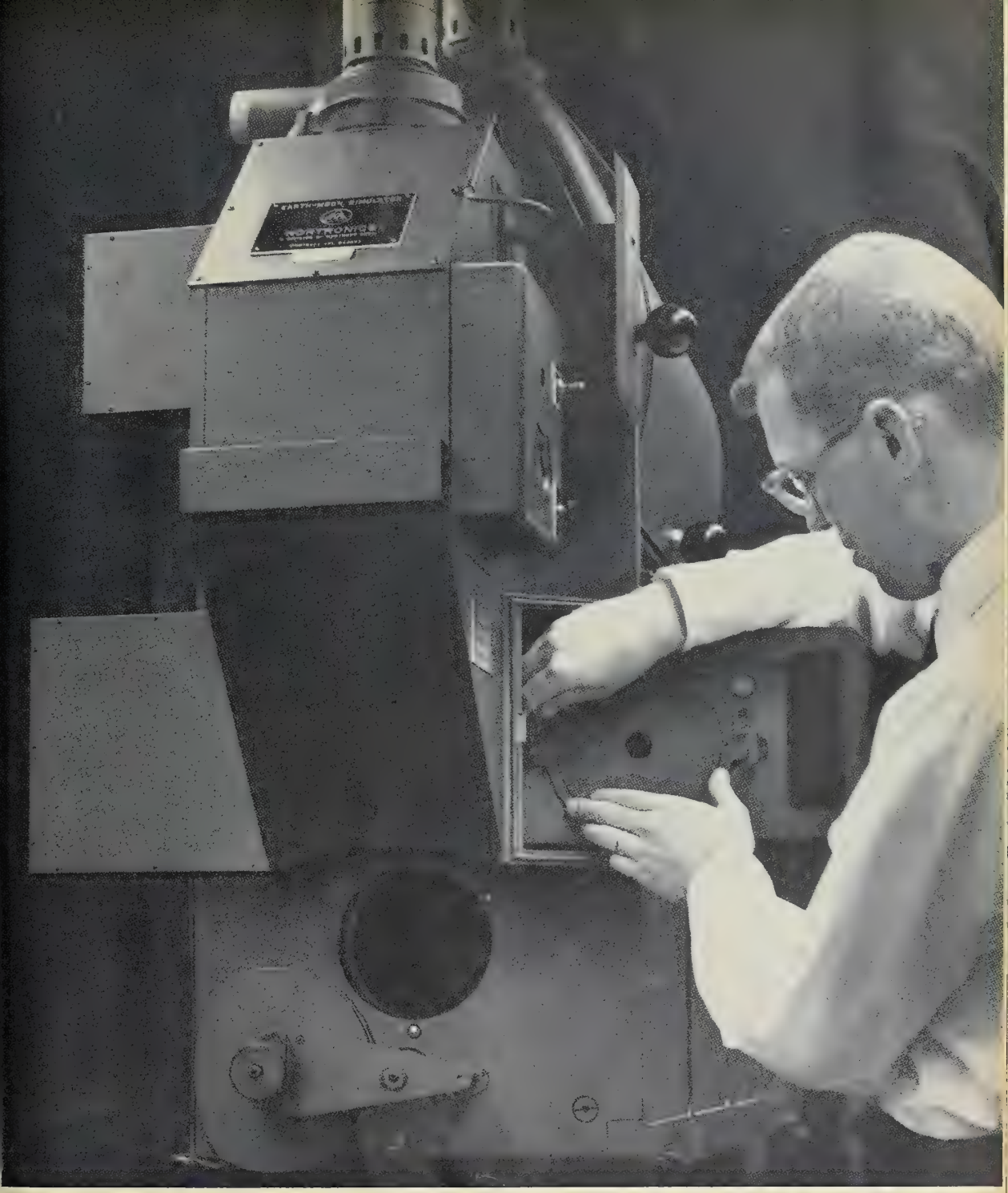
• The *Nimbus* meteorological satellite is being designed for a six-month lifetime.

• Universities should be paid more than the current 15% for overhead costs encountered in the performance of research contracts.

• NASA plans a follow-on series of *Orbiting Solar Observatory* satellites. The much heavier version would utilize the *Atlas-Agena* as its launch vehicle. Its entire weight would always be pointed at the sun. ⠿

Terrier Launched from Carrier

DURING RECENT shakedown cruise, USS Constellation became first aircraft carrier to fire a Terrier test vehicle. Photo shows blast test to starboard side.



We put the earth and the moon in this box—and backed off a billion miles

This is an earth-moon simulator developed by Northrop. As its name implies, it shows us how the earth, or the earth-moon system, would look to an observer in space, from 80,000 miles all the way out to 1 billion miles. It was built to test the sensing devices which space vehicles use to track the earth, so they can guide themselves and point their communications antennas at the earth.

The earth-moon simulator is not only an important research tool, but also a major step toward quality control in space systems. It was designed and built by the Nortronics Division of Northrop. It will be used by Caltech's Jet Propulsion Laboratory, contractor to the National Aeronautics and Space Administration.

NORTHROP

(continued from page 17)

would not completely fill the duct.

The altitude chamber walls will also serve as a neutron shield, being filled with borated water between the double-wall shell to reduce the neutron environment. In case of accident it will also serve as a containment vessel to limit the spread of contamination.

The chamber will also prevent any viewing of engine operation, due to the unavailability of any viewing method capable of withstanding the temperature and radiation environment.

• **Control systems**—Since the possibility of a reactor accident at low power levels is a threat, and uncertain effects of thermal shock on some core materials could cause problems, caution has been followed as to the speed with which the *Kiwi* series reactors have been brought to full power.

The startup time is therefore measured in minutes, but Los Alamos officials point out there is still little time for manual adjustment of controls. Automatic control systems are therefore used for critical parameters of tests.

For the upcoming *Kiwi-B* tests using liquid hydrogen for the first time, LASL will utilize an exit gas temperature control system. In contrast, the *Kiwi-A-Prime* and the *Kiwi-A3* tests had reactor power and propellant flow rate measured as critical parameters independently, and the exhaust gas temperature was calculated as a ratio of these two.

In the future tests, however, propellant flow rate and exit gas temperature are specified quantities, with reactor power becoming the dependent parameter. The temperature control system senses both the demanded temperature and the measured temperature from a thermocouple placed at the exit nozzle, and produces an error signal based on these quantities, the signal then being used to alter reactor power accordingly to provide the demanded temperature.

The *Kiwi-B* series, being tested at Test cells A and C, is using control subsystems having vacuum-tube operational amplifiers. These were selected due to their availability, large output voltage range and the abuse to which they can be subjected before amplifier failure occurs.

LASL test conductors have grouped the control system operational amplifiers together on one chassis for each individual control subsystem, and then placed the chassis in control room racks as required.

In nearly all the control subsystems, the electrical feedback signal is generated at the millivolt level, and chopper amplifiers are used to raise the signal level to ten volts. Los Alamos points out that these chopper amplifiers—Offner 190 model—are "in every sense" sample data systems, with a frequency response unlike any other linear element in analog systems.

Additionally, the use of mechanical choppers gives the units quite an appreciable sampling duration, greatly improving frequency response.

• **LH_2 dewar system** — To avoid cavitation in the inlet stage of the liquid hydrogen pump, the liquid in the dewars must be sufficiently sub-cooled by pressurization so that the gas pressure minus the vapor pressure of the liquid stays above a selected minimum value.

An automatic pressure control system for the dewars was installed because of the variety of conditions varying the liquid hydrogen flow rate and the dewar liquid level.

Overshoot characteristics of the automatic pressure control system were taken into account, since the dewar has a maximum allowable pressure of 120 psi.

The liquid hydrogen valve in the system is an equal-percentage type, and was selected by LASL because it eliminated tank farm pressure as a factor in the open-loop gain. The diffused pressurizing gas flow rate is, however, introduced as a factor; this is not considered a disadvantage, because the steady-state gas flow rate is directly proportional to the product of dewar pressure and liquid hydrogen flow rate.

If the liquid hydrogen flow rate increases or the dewar pressure drops below a preset value, the gas flow rate increases and improves the system's response time when this may be most useful. The controller is designed so that complete system stability is achieved during maximum flow rate through the valve.

• **Reactor power control** — Several changes in the reactor power control system have taken place since the earlier *Kiwi-A* tests, although much similarity remains. The major change is that the *Kiwi-B* series will use 12 rotating control rods within the core, instead of the rectilinear rods formerly used.

By using a sine-squared potentiometer in the position feedback loop, LASL has the advantage of giving signal inputs to the rod package directly in reactivity commands, instead of rod position commands, as was previously the case.

Each of the 12 rods is velocity-limited for safety; simulation studies have shown that this should not occur for any situation which may be reasonably encountered. The variable controlled is the logarithm of reactor power (log Q).

LASL's Sidney Singer describes the setup as follows: The neutronics system used to provide the log Q feedback signals uses specially selected semiconductor diodes, in a feedback loop around an operational amplifier which uses a capacitor chopper in place of the usual mechanical chopper.

This device has a fairly accurate log characteristic, and its stability appears to be markedly better than anything else obtainable. The log Q demand circuit is essentially an integrator protected by an electronic clamp consisting of two amplifiers and a very high back-impedance diode.

The voltage input signal to the integrator is the demanded reactor period. This particular log Q demand circuit is used by the Chief Test Operator in the automatic mode of operation.

The power clamp potentiometer is set at the maximum power desired and the period demand potentiometer is set to obtain the desired reactor period. Should the demanded log Q signal exceed the value set by the power clamp, the error signal to the pair of operational clamping amplifiers become the proper sign to make the diode conduct. The integrator output is therefore clamped at the value set by the power clamp, and the clamping action is independent of the setting of the period demand potentiometer.

In determining how to compensate the log Q system so as to meet test objectives, a number of criteria were considered. Smooth step response is quite desirable. A 30% overshoot, quite often tolerable in other systems, might well (unnecessarily) scram the reactor at a most inopportune time.

The use of liquid hydrogen as a propellant also poses problems, including the possibility of getting a "slug" flow of liquid hydrogen in the reactor reflector. It is therefore impossible to rule out the possibility that blobs of hydrogen may get into the reactor core itself, where the reactivity worth of hydrogen is large.

• **Temperature control** — Unfavorable aspects of the temperature control system in *Kiwi-A* reactors has led LASL to adopt a different technique in the *Kiwi-B* series. This method uses an exit gas temperature measurement put through a temperature loop controller which compares the observed and demanded temperatures and operates on the temperature error to obtain a log Q command signal. The resulting change in reactor power also changes its temperature—and thus the gas temperature at the exit cone.

The gas temperature transducer is a thermocouple placed in the core exit plenum. Similar thermocouples have been used in the past for data-gathering purposes. ⁂

soviet affairs

by Dr. Albert Parry

Gravity is increasingly

one of the most important Space-Age subjects of Soviet research and controversy. "Gravitational Waves—Do They Exist?" is the title of a recent extensive symposium in the Moscow magazine *Znaniye—Sila (Knowledge Is a Force)*. Four well-known Soviet physicist-theoreticians participated. One of them, Profesor Dmitry D. Ivanenko, an outstanding atomic scientist, is noted for his work on the quantum theory of gravitation. In this symposium he declares that, in the study of gravity, mankind is "on the threshold of new discoveries."

After reciting the Western record

of research on gravity, Dr. Ivanenko praises recent Russian work in this field, particularly that done by the team of V. B. Braghinsky and G. I. Rukman. These two physicists have suggested the idea of locating gravitational waves with the aid of complicated and costly equipment consisting of tens of thousands of cylindrical piezocrystals made of titanate of barium. Describing their proposed equipment and method in some detail, Professor Ivanenko comments: "It is a difficult experiment, of course! But it is most desirable to try it out. Nowadays solutions of great problems of principle have often to be wrested from nature at the price of enormous efforts." In effect, he pleads for governmental funds to make such experiments possible.

What practical results

may there be? Will weightlessness be reduced or even eliminated? It is of course too early to give any definite answers to such questions. the attempt to discover gravitational waves is so far a task of pure science only, Professor Ivanenko admits, yet he adds that such a discovery, if made, "will inevitably lead in the future to various applications in technology as well." He writes: "Mankind will perhaps (thus) find an entirely new route of generating gravitational waves and will be able to utilize these waves' wonderful capacities in all their wide scope, including their remarkable ability to penetrate any handicaps wtihout perceptible changes." Gravitational waves may in time be exploited by man for his communications purposes, the Soviet professor suggests.

But the very existence

of gravitational waves is questioned as "problematic" by Professor M. F. Shirokov, another participant in the symposium. "Even if they are finally discovered," he argues, "it is hardly possible that they will have a technical application." The middle-of-the-road position in the symposium, is expressed by M. E. Gertsenshtein, a younger physicist. He says that he is convinced of the existence of gravitational waves in nature, but that "the road to their discovery, reception, and generation is very long." He criticizes the current proposals of equipment to locate and use such waves as "to clumsy and expensive to be put into practice." He speculates nevertheless on the possibility of building, in time, a graviotelescope with unprecedented strength. But he hastens to say: "The creation of such a telescope is an extraordinarily far-off thing." Gertsenshtein is joined by Professor A. S. Kompaneyets, who also does not doubt "the real existence of gravitational waves" but feels that an instrument to intercept and relay them, although possible in principle, would take miles of space to construct, "and perhaps more." He sumarizes: "It is premature to speak about a practical application of gravitational waves. However, should discoveries be made that would cut down on the quantitative requirements of such technology, the question can be posed quite differently."

If not a reduction of weightlessness,

then new communications inventions can be the result. "The day may come," the editors of the Soviet symposium say in closing, "when a graviotelescope, griovatelephone, and graviotelevision will be flesh and blood of our engineering installations."

AERO DYNAMICIST

CAREER APPOINTMENT

The Applied Physics Laboratory of the Johns Hopkins University publishes the HANDBOOK OF SUPERSONIC AERODYNAMICS under cognizance of the U. S. Navy. APL now wishes to appoint an Aerodynamicist to its technical staff to critically review, edit, and occasionally rewrite manuscripts for this publication. The appointment is permanent.

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The Industry Week

Labor Trouble Continues

Senator John McClellan (D-Ark.) said a ban on strikes at defense bases might be the only solution to increasing labor trouble at missile site. "This condition must not be lightly considered or condoned. . . . It is the responsibility of Congress to act," he said, and suggested that the President's Missile Sites Labor Commission was unequal to the task. Labor Secretary Arthur Goldberg, in a letter to McClellan, said work stoppages had taken place because some workers "acted without sanction of their union." He said "prompt and serious consideration" has been given the situation by the President's Commission. Meanwhile, a three-day work stoppage at 12 Atlas silo sites near Walker AFB ended after a marathon 15-hour meeting between AF, union, Labor Commission and the contractor reached an accord. The dispute was between 175 operating engineers and Boeing Catalytic, the contractor.

Bendix Space Share Rises

The Bendix Corp's space activities with NASA last year placed the company fourth in number of contract awards from the space agency and 13th in dollar value. Company President Malcolm P. Ferguson, speaking in New York last week, said the division of the company's business between military/space and commercial segments has been roughly a 70/30 split in favor of the military and space. A breakdown of military sales for 1961 showed 39% going to aviation, and 26% to missile/space projects. "In the last three years," said Ferguson, "the split between commercial and military has not varied much, although the recognized decline in aviation has been more than made up by the growth of our missiles and space business." The company is currently involved with the first $5-million chunk of a $14-million contract for design and development of the mobile ground stations for NASA's *Syncom* satellite, Bendix also is involved in development of the inertial guidance system for *Saturn*, and has prime responsibility for shipboard, ground and satellite communications gear for the Army's *Advent*.

Ferguson said Bendix will spend some $20 million this year for new plant and equipment facilities, including funds for completion of the company's space lab at Ann Arbor, Mich.

GE Sets Up DPO Offices

General Electric established six regional headquarters for its new Defense Programs Operation, and named four regional managers. The Operation will have divisional status and will consolidate field aerospace and defense research, development, and manufacturing activities employing some 75,000 people. Regional headquarters will be in Los Angeles, Washington, D.C., Boston, Huntsville, Dayton, Ohio, and an as-yet-unnamed Midwest location. Regional managers are: Neil Burgess, Los Angeles; George J. McTigue, Washington; Walter F. Greenwood, Boston; and John P. Turner, Dayton. The other two appointments have not been made. General manager of the Operation is Robert J. Brown, former general manager of GE's Heavy Military Electronics Dept. Syracuse, N.Y.

Corporate Financial Reports

Martin Marietta Corp. reported sales of $1.2 billion in 1961, compared to $1.0 billion the year before. Net earnings rose to $44.8 million from $41.3 million. Sales in the Aerospace divisions were $830 million, with the same level predicted for 1962. . . . General Electric Co. sales were $4.5 billion last year, up 2% from 1960. Earnings rose to $242.1 million, a 21% rise over 1960. Sales of the defense products were 25% of the total figure. . . . *Texas Instruments sales were up and earnings down last year. This was attributed in part to "continued level of defense commitments lower than government predictions and industry expectations."* . . . CompuDyne Corp. sales and earnings were up for 1961. Sales were $6.9 million, earnings $301,000 for the year compared to $5.6 million sales and $175,000 earnings the year before. . . . *Amphenol-Borg Electronics Corp. earnings were down to $623,000 last year from $2,185,500 the year before.*

News of Mergers and Expansions

Cuno Engineering Corp., an AMF subsidiary, organized a Tech-Space Division at Meriden, Conn., for design and manufacture of fluid filtration equipment for missiles, aircraft, GSE and military and commercial reactors. . . . *Kearfott Division of General Precision, Inc. is recruiting top-level aerospace scientists to man its new 70,000-sq.-ft. research center, scheduled for completion this fall at Little Falls, N.J.* . . . Humphrey, Inc., an aerospace component supplier, established a Wichita, Kan., Division. . . . *Electronic Communications, Inc. opened a regional office in Huntsville, Ala.* . . . General Electrodynamics Corp., Garland, Tex., began operation of its Astron-Optics Division. The division will work on a job-order basis for custom optical component requirements.

Changes in the Front Office

Dr. Marvin Stern will become corporate vice president-research and engineering for North American Aviation, Inc. Stern has been deputy director of defense research and engineering for weapons systems in the Pentagon. He has been in DOD research and engineering activities since August, 1960. It is reported that DOD will divide Stern's responsibilities into two new posts, probably to be designated director of tactical warfare programs and director of strategic and defensive systems. . . *E. E. Nelson has been chosen Manager of Aerojet General's Space Booster Plant, to be built on a 75,000-acre site south of Miami. Nelson is the former assistant to Aerojet President Dan Kimball.*

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contracts

AIR FORCE

$10,835,379—**General Dynamics/Pomona,** Calif., for technical data and manuals for F series *Atlas* missiles and for equipment, spare parts and special tools for installation and checkout of *Atlas* missiles.

$7,305,000—**Burroughs Corp.,** Paoli, Pa., for production of equipment for the NORAD Combat Operations Center (supplemental contract).

$5,750,000—**Martin Marietta Corp.,** Denver, for activation of *Titan* sites at Ellsworth, Mountain Home, Larson and Beale Air Force bases (supplemental contract).

$5,144,000—**Lockheed Missiles and Space Co.,** Sunnyvale, Calif., for long-lead-time items to support *Agena* space vehicles (supplemental contract).

$4,200,000 — **Aerojet-General Corp.,** Sacramento, Calif., for applied research for further development of a thrust vector control system (supplemental contract).

$4,090,679—**General Electric Co.,** Philadelphia, for work on project *Advent* and for designing and producing inter-complex communications systems for *Titan II* missiles, work to be performed in Philadelphia and Lynchburg, Va.

$3,500,000—**General Electric Co.,** Philadelphia, for work on space vehicles for a classified mission.

$2,600,000—**Radio Corp. of America,** Moorestown, N.J., for work on the BMEWS system.

$2,500,000 — **General Dynamics/Astronautics,** San Diego, Calif., for global tracking network.

$2,500,000—**General Electric Co.,** Syracuse, N.Y., for fabrication and installation of radomes at Cottonwood, Idaho, and Mount Hebo, Ore.

$2,210,013—**North American Aviation, Inc.,** Canoga Park, Calif., for production of and provision of support services for *Atlas* missile propulsion systems (supplemental contract).

$2,000,000—**Lockheed Propulsion Co.,** Redlands, Calif., for building and conducting feasibility tests on a solid-propellent rocket motor 120-in. in diameter and construction of segments to form complete booster.

$1,800,000—**Massachusetts Institute of Technology,** Cambridge, Mass., for research on re-entry physics, acquisition of special equipment and research on range measurements (supplemental contract).

$1,600,000—**Hughes Aircraft Co.,** Culver City, Calif., for development of a missile fire control system (supplemental contract).

$1,347,000—**General Motors Corp., AC Spark Plug Division,** Flint, Mich., for modification kits, installation of modification kits, supporting spare parts, MIP's, ECP's, engineering, prototyping, TCT's and engineering data in support of *Thor* and *Titan* guidance subsystems.

$1,316,502—**General Dynamics Corp.,** San Diego, for provision of support equipment and spares for *Atlas* missiles.

$1,000,000—**Hercules Powder Co.,** Wilmington, Del., for production of Stage III *Minuteman* engines (supplemental contract).

$815.230—**Douglas Aircraft Co., Inc.,** Santa Monica, Calif., for maintenance on the *Thor* missile weapon system.

$312,829—**Defense Electronics, Inc.,** Rockville, Md., for special purpose telemetry receiving, storage, data formating and transmitting system.

$200,000—**Burroughs Corp.,** Radnor, Pa., for technical data.

$95,000—**Lockheed-California Co.,** Burbank, Calif., for a study of non-winged re-entry configuration shapes at speeds up to 15,000 mph.

ARMY

$10,204,894—**Ford Motor Co., Aeronutronic Div.,** Newport Beach, Calif., for continued development of the *Shillelagh* missile (definitization of letter contract plus additional new funds).

$3,948,309—**Greenhut Construction Co., Inc.,** Pensacola, Fla., for construction of research and development center facility at Redstone Arsenal, Ala.

$5,171,535—**Raytheon Co.,** Lexington, Mass., for *Hawk* missile ground support equipment, including radar set (2 contracts).

$1,587,151—**Radio Corp. of America,** Camden, N.J., for equipment to be used in testing missile system components.

$233,801—**Western Electric Co.,** New York City, for preparation and presentation of a training course including materials, for anti-jam display modifications to the *Nike-Hercules* acquisition radar, procurement of replenishment spares for the missile (3 contracts).

$162,057—**AAA Electrical Contractors and Engineers, Inc.,** Atlanta, for construction of unit substation and distribution lines at Redstone Arsenal, Ala.

$55,998—**Pesco Products Div., Borg-Warner Corp.,** Bedford, Ohio, for cooling units for *Hawk* missile.

NAVY

$27,000,000—**General Dynamics/Pomona,** Calif., for *Terrier* and/or *Tartar* missiles components.

$8,090,450—**Martin Marietta Corp.,** Orlando, Fla., for *Bullpup* missiles for the Air Force.

$8,000,000—**Thiokol Chemical Corp., Reaction Motors Div.,** Bristol, Pa., for *Bullpup A* rocket engines.

$1,658,281—**Chance Vought Corp., Div., Ling-Temco-Vought, Inc.,** Dallas, for materials and services to convert *Regulus II* tactical missiles to *KD2U-1* target drones.

$1,358,905—**Vitro Laboratories Div., Vitro Corp.** of America, Silver Spring, Md., for engineering services for coordination of surfaced-launched guided missiles.

$750,000—**Westinghouse Electric Corp.,** Washington, D.C., for receiving and data processing equipment, navigation set, radio, for *Transit* satellite.

$437,947—**Corps Construction, Ltd.,** Kailua-Kona, Hawaii, for Pacific Missile Range facilities, Hawaiian tracking station.

$286,260—**Curtiss-Wright Corp., Wright Aeronautical Div.,** Wood Ridge, N.J., for coordination of *Polaris A-3* first-stage rotating nozzle installation details with respect to both the flight vehicle and the ground test motor and design of an *A-3* first-stage full-scaled lithium-cooled rotating nozzle system.

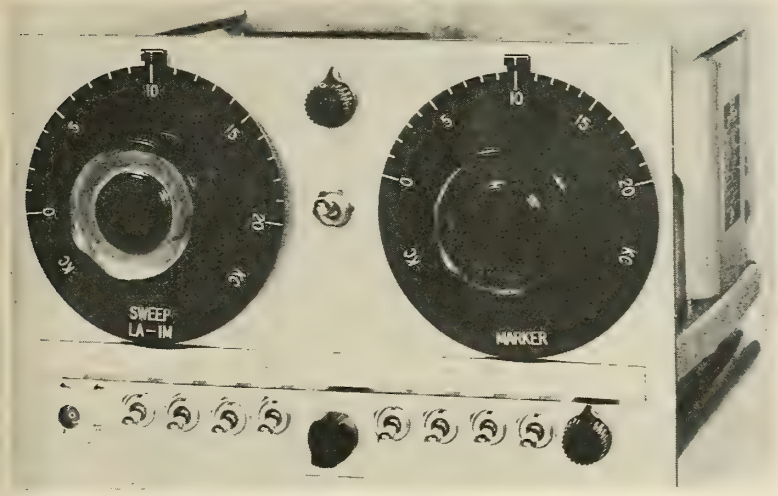
$184,099—**Fairchild Camera and Instrument Corp., Department of Defense Products Div., Clifton, N.J.,** for research and development of near infra-red sensitive electro-visual guidance system.

$71,000—**Defense Electronics Div., General Electric Co.,** Utica, N.Y., for field engineering services for installation, repair, modification and servicing of *Sidewinder* missiles (2 contracts).

$52,638—**Washington Technological Associates,** Rockville, Md., for design and fabrication of equipment stands, guidance capsule stands, re-entry body stand, first-stage motor dolly stand, second-stage motor dolly stand and guidance capsule monorail handling system.

NASA

$3,000,000—**Military Electronics Div., Motorola, Inc.,** Scottsdale, Ariz., for research and development for the Goddard Range and range rate tracking system.



New Product of the Week: Plug-in Sweep Oscillator

TELONIC INDUSTRIES, Inc., has announced a new plug-in sweep oscillator covering a frequency range from 20 cycles to 20 KC. Designated model LA-1M it will cover a center frequency from 20 to 20,000 cps and sweep widths of 50 to 20,000 cps, furnishing 15 volts p-to-p into 50 ohms.

Sweep rate may be adjusted for optimum frequency change versus time ratio for scope or recorder presentation. Retrace may be adjusted from 50% to 5% of the sweep period to economize testing time.

A market system, built into the plug-in unit includes provisions for eight crystal-controlled pulse type markers, and an input for an external marker.

Circle No. 225 on Subscriber Service Card

High-Density Delay Line

Columbia Technical Corp., has available a series of high-density, high delay-to-rise time ratio delay lines. CTC-1284, a typical Q-Line model, contains three separate delay networks in a 44-in.^{3} package. The total combined delay/rise time ratio is 120/1, including one line with a 80/1 ratio. Bandwidth of this delay line is 5Mc. Temperature coefficient is 50 PPM/°C. Attenuation is 0.1 db/usec. It has a distortion of 3%. The unit is hermetically sealed and meets military requirements.

Circle No. 226 on Subscriber Service Card

Magnetic Material

A ductile permanent magnetic material, called Vicalloy, capable of being rolled to thickness of less than one-half of one-thousandth of an inch, is available from Westinghouse Electric Corp. Composed of 52% cobalt, 10% vanadium and 38% iron, it can be fabricated into tape, wire, bar and sheet stock and can be punched, drilled, tapped, bent, drawn, coiled and machined without cracking or tearing.

Vicalloy can be used in the manufacture of electromechanical devices, such as computers or recorders, and is especially suited for the manufacture of permanent memory devices for high-speed digital computers. The alloy can be used in any ambient up to 600°F without causing variations in magnetic characteristics.

Circle No. 227 on Subscriber Service Card

Digital Circuit Modules

Control Logic, Inc. is marketing compatible, ultra-high-reliability welded digital transistor circuit modules which operate from d-c to 10 megacycles. They are available in high-density ejection-molded modules, with up to two circuits per module, as well as a card series with up to four modules mounted on glass epoxy cards.

Circle No. 228 on Subscriber Service Card

All-Solid-State Quadrature

An all-solid-state, self-calibrating quadrature standard which provides a 90° phase shift accurate to 0.01° is available from Gertsch Products, Inc. The unit is equipped with two integrating amplifiers which accomplish the precision, self-calibrating feature. Each

integrator has independent phase and gain controls, and necessary circuitry to accomplish required adjustments when the instrument is combined with the Gertsch NI-4 phase-sensitive null indicator, or other suitable detector.

Circle No. 229 on Subscriber Service Card

Elapsed Time Meter

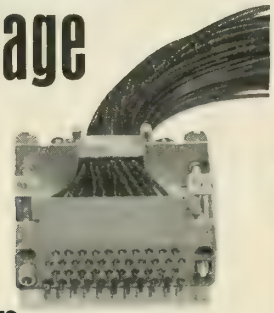
A miniature elapsed time meter has been introduced by Burtis Instruments, Inc. for 115V a. c. use. The Indachron, with an integral rectifying and regulating circuitry, is installed directly across the line voltage. It is expected to find broad use in applications such as preventative maintenance scheduling, parts renewal scheduling, warranty validation, and reliability testing.

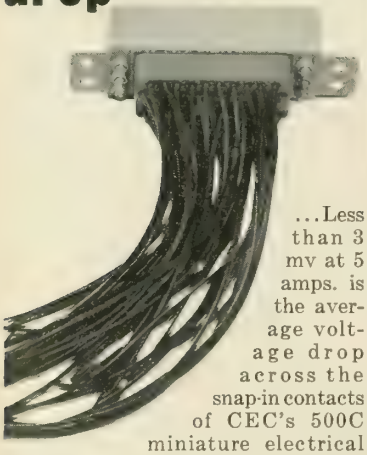
Circle No. 230 on Subscriber Service Card

Counter-Timer

An electronic frequency counter-timer, offering a unique combination of advantages, is now available from the Ransom Research Div. of Wyle Laboratories. Specifications include: 250 kc count rate; 5-digit, in-line projection display readout; 0.25v rms sine or square-wave input sensitivity; crystal oscillator time base; 100 kc clock output; external clock input; "Ready" output;

Miniature connectors with minimum voltage drop





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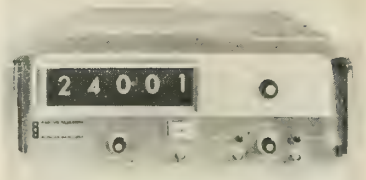


0.1, 1, and 10 second frequency time gates; 1, 10, and 100 cycle period sample times. Special configuration can easily be provided.

Circle No. 231 on Subscriber Service Card

Environmental Chamber

A 12-cu.-ft. environmental chamber is available from Enviraton Co. It is designed to reproduce extreme environments of altitude, temperature and humidity simultaneously, simulating altitudes from sea level to 100,000 ft. temperatures from —300°F to 400°F, and relative humidity from 10% to 95% over a broad temperature range. The chamber can be used to evaluate the performance of equipment subjected to any combination of these environmental conditions. Air within the chamber is recirculated through a heat exchanger where it is heated, cooled, or humidified. Programming equipment can also be included.

Circle No. 232 on Subscriber Service Card

Time Delay Relay

George Harmon Co., Inc., has available a lightweight, solid-state, hermetically sealed time delay relay. The relay actuates electronic circuitry or electrical devices at a predetermined interval after application of voltage. Uses include the starting of a bank of motors without overload, drone parachute ejection, and warming up banks of electronic tubes without causing cathode damage.

Circle No. 233 on Subscriber Service Card

new literature

TRANSISTOR BROCHURE—A four-page specification sheet describing low-noise PNP silicon-alloy transistors has been issued by Sperry Semiconductor, division of Sperry Rand Corp. It includes schematics, performance curves, characteristics charts and drawings. These transistors are offered in both the TO-5 and TO-18 case and are designed for use in low-level pre-amplifier stages where minimum transistor noise is required.

Circle No. 200 on Subscriber Service Card

INSULATING MATERIALS—The first complete catalog of Scotch and Irvington brand splicing and insulating materials used in communications and signal systems is available from Minnesota Mining and Manufacturing Co. The 16-page catalog describes more than 30 items—including tapes, resins, splicing kits, self-stripping wire connectors, splice sleeves and cable blocking materials. Technical data, application photos and "how-to-order" information are listed for all products.

Circle No. 201 on Subscriber Service Card

POWER SUPPLY MODULES—Custom/Power, a division of Trio Laboratories, Inc., has published a new eight-page, two-color, illustrated catalog describing its new line of Custom/Power prefabricated regulated power-supply modules.

Circle No. 202 on Subscriber Service Card

MONITORING EQUIPMENT—A folder from CompuDyne describes Alertra Model 901 remote monitoring equipment. Designed for continuous remote monitoring of limits, using a single channel of any communications medium, the system transmits bits of binary data. Solid-state circuitry used throughout is based on economical plug-in modules.

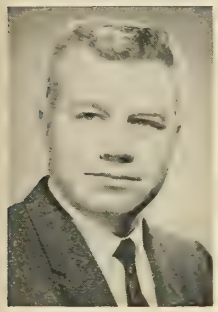
Circle No. 203 on Subscriber Service Card

TRANSFORMER SIMULATOR—Electronic Research Associates, Inc., has published a technical bulletin providing descriptive information on Model TS460 transformer simulator. This instrument provides the equivalent of a multi-winding transformer with up to 4 independent removable center-tap secondaries which offers the engineer the convenience and flexibility of simulating all types of transformers on the laboratory bench. The bulletin provides full descriptive information, operating data, detailed specifications and applications.

Circle No. 204 on Subscriber Service Card

Circle No. 13 on Subscriber Service Card

names in the news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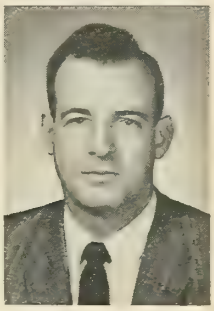
BEARD

Eight scientists have been named as laboratory directors to head the streamlined laboratory setup at Army Missile Command, Redstone Arsenal, Ala.: **Delman E. Rowe,** electromagnetics; **Holm Hinrichs,** structures and mechanics; **Frank W. James,** propulsion; **W. C. Watson,** launch and ancillary equipment; **Jess B. Huff,** guidance and control; **William P. Lloyd,** test and evaluation; **John P. Hallowes, Jr.,** research; and **Robert E. Lavender,** advanced systems. The Army Rocket and Guided Missile Agency and the Army Ballistic Missile Agency were recently absorbed into the Army Ordnance Missile Command as part of its reorganization. Each agency prevously had operated five R&D labs. The new eight-lab organization was created from the 10 labs of the agencies.

John C. Herther: Senior Staff Engineer at Itek Laboratories, Lexington, Mass., has been named president of the New England Section of the American Rocket Society.

Robert F. Flood: After having served in various capacities in Linde Co., division of Union Carbide Corp., New York City, has been promoted to executive vice president.

Edmund Q. Sylvester: President of the American Ship Building Co., made a director of the National Screw & Manufacturing Co., Cleveland.

James J. Ling: Will fill the new position of vice chairman of the board of Ling-Temco-Vought, Inc., Dallas.

Arthur E. Raymond: Widely-known astronautics engineer, designer and manager, has been appointed special consultant to the Administrator of the National Aeronautics and Space Administration.

Don H. Peaker: Made chairman of the board of directors of U.S. Beryllium Corp., Peublo, Colo. At the same time, former vice president **Willard D. Egolf** was named as the new president. He will continue to serve as secretary and general counsel.

Harry L. Brown: Joins Guidance Technology, Inc., Santa Monica, Calif., as vice president-engineering.

L. J. Bonis: Will succeed **Neil E. Rogen** as president of Ilikon Corp., Natick, Mass.

J. Hunter Reinburg: New manager of the Washington, D.C., office of Gulton Industries, Inc.

George H. Bruns, Jr. and **William F. Gunning:** Appointed to the board of directors of Astrodata, Inc., Anaheim, Calif.

Dr. C. W. Walton: Named vice president for research and development of Minnesota Mining & Manufacturing Co., St. Paul, while **J. W. Selden** was made division vice president of the new products commercial development.

Robert H. Borders: Becomes affiliated with Schaevitz Engineering, Pennsauken, N.J., as executive vice president and a member of the board of directors.

Edward J. Jason: Formerly associated with the Guided Missile Range Division of Pan American World Airways, joins National Engineering Incorporated, Brockton, Mass., as president.

Dr. William A. Robba: Relinquishes position with the Atomic Energy Commission to serve as vice president and director of research and development for Space Age Materials Corp., Woodside, N.Y.

Charles E. Beard: Promoted to Manager for the General Electric Company's Heavy Military Electronics Department, Syracuse, N.Y.

Charles C. Camillo: Appointed to the post of vice president, engineering, of FXR, the r-f products and microwave division of Amphenol-Borg Electronics Corp., FXR is located in Danbury, Conn.

Eugene J. Moscaret: Will fill the newly created position of director of marketing for the Transducer Division, Consolidated Electrodynamics Corp., Monrovia, Calif.

Dr. Gertrude Blanch: Research mathematician on the staff of the Air Force's Aeronautical Research Laboratory, Wright-Patterson AFB, Ohio, has become the first woman to be appointed a Senior Scientist in the Department of Defense. The position is one authorized by Public Law 313 for exceptionally well-qualified scientific and professional Government employees.

Richard W. Hanford: Joins White Electromagnetics, Inc., Bethesda, Md., as vice president and technical director.

William T. Summerlin: Formerly manager of the engineering reliability and components department of Philco, has been named manager of engineering reliability for McDonnell Aircraft of St. Louis. Also, **Grant D. Christensen** was made manager of engineering services at the same time.

Dr. William A. LaLande, Jr.: Will fill the vacancy created by the resignation of **Philip T. Sharples** on the board of directors of the Pennsalt Chemical Corp., Philadelphia.

C. David Auman: Will act as director of the new Special Projects Group of Special Devices, Inc., Newhall, Calif.

Rolland F. Ackermann and **Dr. Arnold H. Scott:** Physicists at the National Bureau of Standards, have been awarded Silver Medals for Meritorious Service by the U.S. Department of Commerce; Dr. Scott for his many years of service to the standards mission of the Bureau in the field of precision measurements of the dielectric properties of matter, and Ackermann for extremely competent and creative performance of duties in connection with the development of high-precision techniques and equipment used for calibration of line standards of unusual length.

John C. Schuessler: Named chief engineer of the Connector Division of Microdot Inc., South Pasadena, Calif.

C. Lincoln Jewett: Joins Consolidated Vacuum Corp./CEC/Bell & Howell Rochester, N.Y., as vice president-marketing.

Donald E. Stocking: To fill the newly created position of director of marketing for the Data Recorders Division, Consolidated Electrodynamics Corp., Pasadena, Calif.

MOBILIZING FOR THE MOON

About fifty-billion dollars will be spent in the next decade to develop the moon program—80% with industry.

NOVEMBER 27, 1961 — MISSILES AND ROCKETS published its NASA Issue, an in-depth study of the National Aeronautics and Space Administration's programs, projects, facilities, personnel, and contracting procedures—emphasis centered on NASA's future material and contract requirements. JANUARY 5, 1962 — Over 1,000 single copies ordered by companies and individuals. JANUARY 11, 1962 —NASA purchased 60,000 reprints of the editorial section of the NASA issue.

NOW— MISSILES AND ROCKETS, for the first time, offers companies interested in doing business with NASA the opportunity to buy reprints of the editorial section of the NASA Issue—1961's most important and informative missile/space publication.

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MARCH

Second National Symposium on Hypervelocity Techniques, Denver Research Institute, University of Denver, Colo., Mar. 20-21.

Symposium on High-Temperature Solution Chemistry, American Chemical Society and Office of Aerospace Research, Chemical Sciences Directorate, Washington, D. C., Mar. 20-26.

American Chemical Society National Meeting, Washington, D. C., Mar. 20-29.

Society for Industrial and Applied Mathematics Spring Meeting, California Institute of Technology, Pasadena, Mar. 23-24

International Convention of Institute of Radio Engineers (IRE), Coliseum and Waldorf-Astoria Hotel, New York City, Mar. 26-29.

Third Symposium on Engineering Aspects of Magnetohydrodynamics, sponsored by Univ. of Rochester, AIEE, IRE, IAS, Univ. of Rochester, N. Y., Mar. 28-29.

APRIL

Launch Vehicles: Structures and Materials Conference, sponsored by the American Rocket Society, Ramada Inn, Phoenix, Ariz., April 3-5.

Second Symposium on the Plasma Sheath, sponsored by Electromagnetic Radiation Laboratory, Electronics Research Directorate, L. G. Hanscom Field, Mass., April 3-5.

Nineteenth Annual Conference, Society of the Plastics Industry Western Section, Hotel Del Coronado, Coronado, Calif., April 4-5.

American Society for Quality Control Workshop—Seminar on Management of Quality Control, Hollywood Roosevelt Hotel, Los Angeles, April 4-6.

American Institute of Electrical Engineers South Central Meeting, Hotel Peabody, Memphis, April 4-6.

Thirteenth Annual Advanced Statistical Quality Control Institute, Univ. of Connecticut, Storrs, April 8-20.

American Institute of Electrical Engineers, Rubber and Plastics Industries Conference, Sheraton Hotel, Akron, April 9-10.

Instrument Society of America, National Chemical and Petroleum Instrumentation Symposium, Wilmington, Del., April 9-10.

Thirty-third Annual Scientific Meeting of Aerospace Medical Association, Chalfonte-Haddon Hall, Atlantic City, N. J., April 9-12.

American Society of Mechanical Engineers, Metals Engineering Conference, Sheraton-Cleveland Hotel, Cleveland, April 9-13.

Spring National Convention, Society of Nondestructive Testing, Pick-Carter Hotel, Cleveland, April 9-13.

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The Goddard Memorial Trophy

IT IS ALWAYS a pleasure to sing about an unsung hero. Robert R. Gilruth, Project *Mercury* director and winner of this year's Goddard Trophy, fills many of the requirements for that figure so dear to the hearts of editorial writers.

While Astronaut John Glenn was swinging around the earth in *Friendship 7* under a full blaze of publicity, Robert Gilruth had his feet planted firmly on the ground in *Mercury* Control. While Glenn was greeted with wild acclaim on his rides down Pennsylvania Avenue and through the canyons of New York City and while he appeared before the Joint Meeting of Congress, Mr. Gilruth remained in the background.

But for Robert Gilruth, the resemblance to an unsung hero ends right about there.

When President Kennedy pinned the Distinguished Service Medal of the National Aeronautics and Space Administration on Col. Glenn at Cape Canaveral, he also pinned the same medal on the lapel of the Project *Mercury* director.

President Kennedy cited Mr. Gilruth for his "distinguished leadership of the team of scientists and engineers that carried Project *Mercury* . . . from its inception to the successful accomplishment of manned flight in orbit."

The Goddard Trophy Committee has cited Mr. Gilruth for his "personal dedication in leading the Project *Mercury* team." The *Mercury* director, like Col. Glenn, has been quick to emphasize that the honors he is receiving are due in fact to the entire *Mercury* team.

The Distinguished Service Medal and the Goddard Trophy, however, are far from the first awards won by Mr. Gilruth.

In 1950, for his efforts in establishing what now is NASA's Wallops Island station, Mr. Gilruth received the Sylvanus Albert Reed Award of the Institute of Aeronautical Sciences.

In 1951, the same achievement brought him the Federal government's Superior Accomplishment Award.

In 1954, Mr. Gilruth received the University of Minnesota Outstanding Achievement Award, established by his alma mater for former students "who have attained high eminence and distinction."

So the distinguished work of Mr. Gilruth in aeronautics and astronautics was bringing him awards when *Mercury* still was only the name of a winged messenger.

We like Mr. Gilruth's sharing of the acclaim with the *Mercury* team. But the Goddard Trophy is going to Robert Gilruth for his personal leadership. It is not an award to the *Mercury* team. We are sure that is just the way the *Mercury* team would want it.

There can be little doubt that the personal efforts of the Project *Mercury* director contributed in large measure to the success of a program about which there were some serious doubts in the past. Success, in such cases, tastes even sweeter.

Mr. Gilruth's achievement has won him another award of which he can perhaps be even prouder—the task of leading the development of the *Apollo* spacecraft which will make the first manned U.S. flight to the moon. The nation can be confident its most important space program is in the hands of an exceedingly capable individual. Mr. Gilruth is a worthy recipient of the Goddard Trophy.

WE WOULD LIKE to make a few comments about the awarding of this year's Goddard Trophy. The Goddard Memorial Trophy was established five years ago by this magazine. For the first four years, the members of the MISSILES AND ROCKETS editorial staff elected the trophy winner. This year, for the first time, a committee of distinguished members of the missile/space field was asked to make the nominations and to select the winner. The committee includes outstanding representatives from the three military services, the government and industry.

This was done because the editors of the magazine and the officials of the National Rocket Club, under whose auspices the trophy is awarded, felt it would serve to give what had become a major trophy even broader significance.

There is a further, and most significant, development in regard to the trophy which we feel will be of interest. From its inception, the trophy itself has been donated by MISSILES AND ROCKETS. That was to have been the case again this year.

But a few weeks ago Mrs. Robert H. Goddard asked us if she could take over annual donation of the trophy as a way of expressing appreciation for the honors bestowed upon her by the government and industry in the name of her late husband. We have, with great pleasure and a feeling of honor, acceded to Mrs. Goddard's request.

MISSILES AND ROCKETS will continue to supervise selection of the trophy winner under the auspices of the National Rocket Club.

We feel that under the new arrangements the Goddard Memorial Trophy will take its rightful place as the nation's highest award in the field of astronautics. We are happy and proud to have played a role in this.

And again we want to congratulate Mr. Gilruth on his selection as this industry's Man of the Year.

William J. Coughlin

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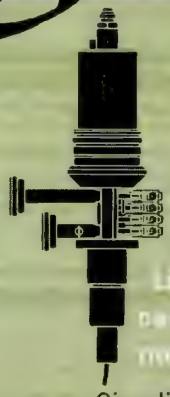

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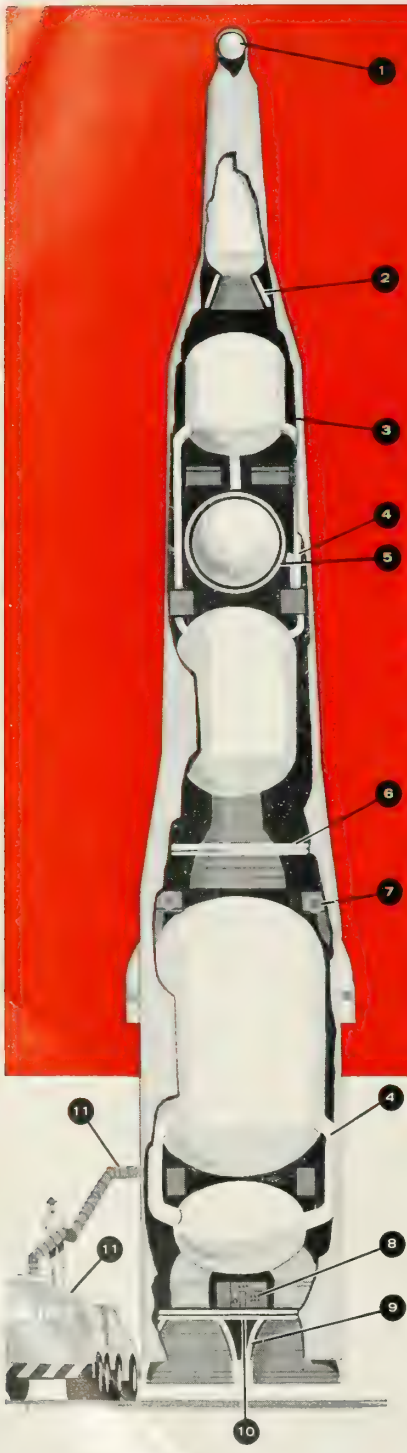

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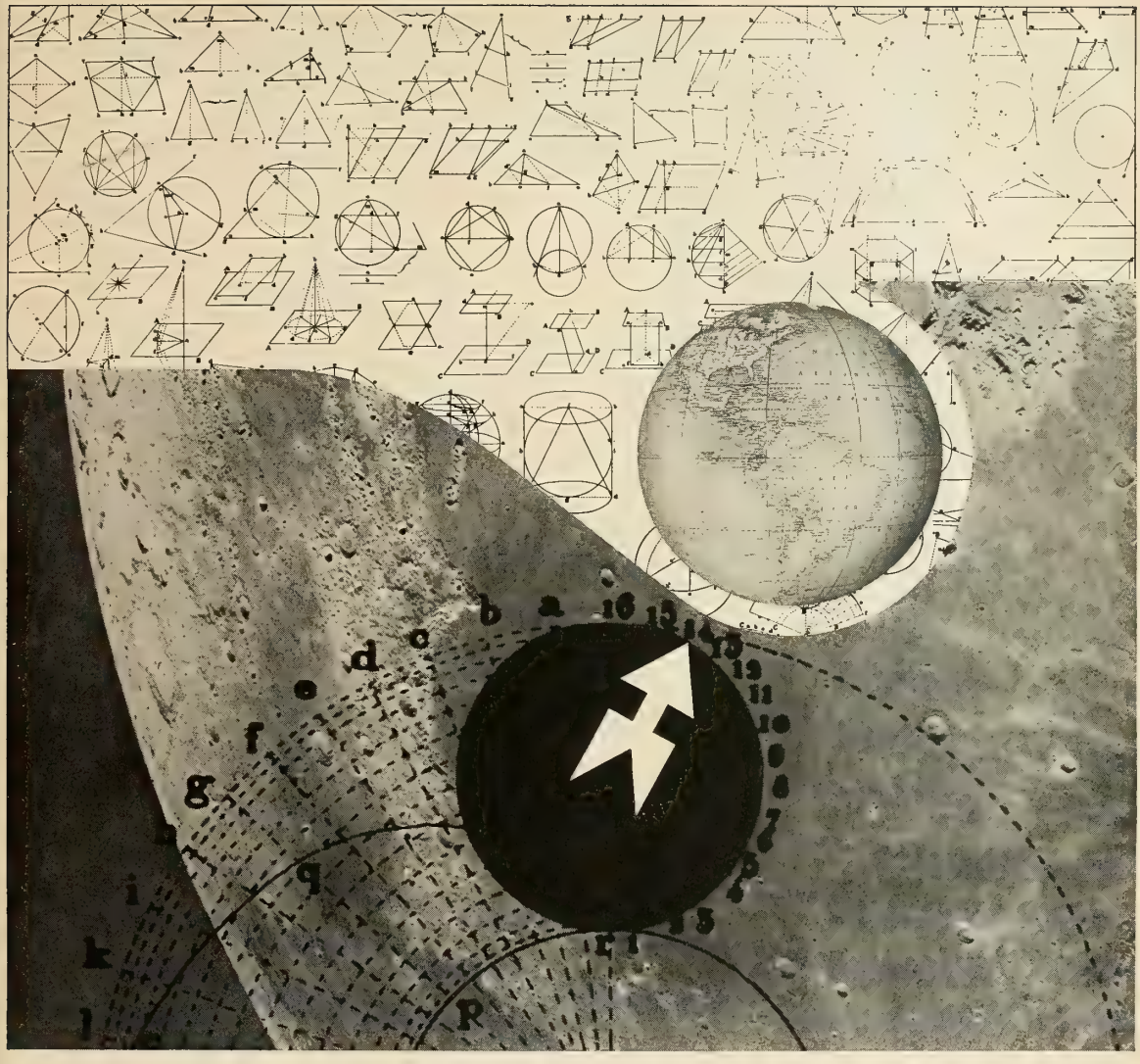

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Volume 10, Number 13 March 26, 1962

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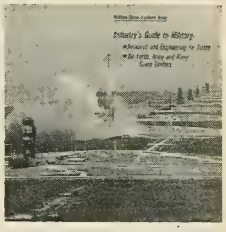
THE COVER

An AF Titan rises from a pad at Cape Canaveral. View south down the Cape shows space launch facilities representing gathering U.S. military drive into space—theme of this special issue of MISSILES AND ROCKETS.



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memo from the publisher

LAST WEEK, two of the industry's top scientists appeared before the House Manned Space Flight Subcommittee to discuss the nation's spaceflight programs. They were Dr. William Baker, vice president-research, American Telephone & Telegraph Co., and Dr. George Haller, vice president-research, General Electric Co.

The hearings concerned the Fiscal 1963 budget of the National Aeronautics and Space Administration. Both firms are deeply involved in NASA's manned space flight program.

Both witnesses emphasized the same point to the committee: Ways must be found within the limits of the National Space Program to exploit potential weapons developments when they become apparent.

Dr. Baker said: "We have not seen a national policy that defines the positive role of the military. It limits or prescribes its part (in a national program) but it does not explain its role."

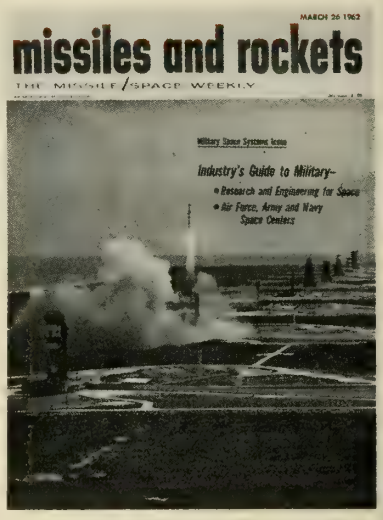
That is one of the reasons behind this special issue. The editors of MISSILES AND ROCKETS feel the military role in space needs much clearer definition. To assist in this, they have tried to spell out where our military space program stands today. You will find in this issue a rundown of current and proposed military space systems, military space budgets and plans, and the nation's military space facilities.

In defining the military space role, we must be acquainted with the tools available. For many weeks, the editors have been visiting military space centers throughout the nation to gather material for this issue. Not all of the information comes from the military. Some has been supplied by industrial and Congressional sources.

To our knowledge, it is the first time any magazine has put together in a single package a readout of the nation's total military space capability.

Our companion National Aeronautics and Space Administration issue of last November 27 on the civilian space program has been widely read in Congress, as elsewhere. Several members of Congress have told us the NASA issue was valuable to them in preparing for the hearings on the NASA budget. We hope this week's book will be just as helpful.

In preparing the issue, the editors also have tried to make it a worthwhile tool for those in the industry who are doing space business with the military, or who plan to do so.


MARCH 26 1962
missiles and rockets
THE MISSILE/SPACE WEEKLY
Military Space Systems Issue
Industry's Guide to Military—
• Research and Engineering for Space
• Air Force, Army and Navy Space Centers

There are several ways the issue can be used. If you are interested, for example, in a specific program such as the Army's *Advent*, you will find information on budgeting for *Advent* in the overall budget story, facts on the project itself in the spacecraft story, and an analysis of *Advent* management and procurement in the article on the Army centers concerned.

If you have a broader interest, say, in electronics, you can consult the general article on electronics which will guide you to the military centers involved in electronic development and procurement and from there to the programs.

We hope you will find the issue a valuable reference throughout the year.

ANOTHER special report now in the planning stage will, we feel, be of major interest. The May 21, 1962, issue of MISSILES AND ROCKETS will carry an extensive special report on the Manned Lunar Program. With initial contracting on Project *Apollo* now well under way, both the industry and NASA are moving quickly to set up the *Apollo* organization. Latest information on the *Apollo* program, including procurement details, will be the highlight of the May 21 issue. NASA and the prime contractor, North American Aviation, are cooperating with us on this report. We think you'll find it useful.

James R. Clear

OFFICE OF THE PUBLISHER

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letters

More Launch Opportunities

To the Editor:

The ten launch postponements prior to the successful *MA-6* orbit flight have prompted this writer to offer a few brief remarks concerning the launch delay problem as it will affect future *(Gemini, Apollo, Dyna-Soar)* space projects.

The *Friendship 7* delays were of course unfortunate for all concerned, but were to be expected due to the unforeseen problems arising in the nation's first manned space project and the earnest desire that it be a success. Experience and improved techniques will eliminate many of the present reasons for launch delays of the one-stage *Atlas/Mercury* capsule.

But the following questions may be asked: (a) What will be the probable launch delay period for the far more complex manned vehicles of the future—having three or more crew members and from two to three rocket stages for the *Apollo* earth-orbit rendezvous mode (or up to five-to-seven for "projected" *Nova* direct flights)?, (b) What additional direct operating costs will be incurred because of these delays?, and (c) What additional payload penalties will result if precise launch-on-time does not occur as dictated by earth-orbit rendezvous or direct-lunar launch window conditions?

Major effects of these problems can be minimized through three key orbital operations procedures:

A. Use of *rendezvous-compatible orbits* (RCO's) to provide convenient twice-daily synchronism of the launch base with the target satellite station or orbital assembly base.

B. Implementation of an *RCO station keeping system* to maintain rendezvous compatibility with the launch and recovery bases.

C. Employment of *low-altitude parking orbits* (about 100 n. mi.), providing optimum (in-plane) launch opportunities to an RCO-constrained orbital assembly base (at an altitude of about 262 n. mi. and inclination of 31°).

Proper selection of the orbital altitude and inclination combination can provide the required synchronism of the orbital assembly base with Cape Canaveral, so that two optimum in-plane launch opportunities will occur each day.

Many other combinations of altitude and inclination may be considered. A typical good combination for two optimum launch opportunities per day is an altitude of 262 n. mi. and inclination of 31° for Cape Canaveral. Thus a first launch opportunity with a north-going base will occur at time zero, and a second opportunity with a south-going base three hours and 8.76 minutes later. Successive opportunities will occur each day thereafter, provided the orbital assembly base is maintained on this nominal RCO through station-keeping techniques. Station-keeping costs are estimated to be about 32 f./sec. per year of characteristic velocity for a

typical satellite vehicle having an area loading of 100 lbs. per ft.^{2}.

Perhaps an even more useful RCO would be that having an inclination of about 35° and an altitude of 264 n. mi. This alternative combination will provide two optimum in-plane launch opportunities from the Cape—with one near-optimum in-plane recovery opportunity at Edwards AFB.

Norman V. Petersen
Hawthorne, Calif.

Strange Patent Bedfellows

To the Editor:

In your recent editorial on "The Two Sides of the Patent Coin" (M/R, Dec. 11), the omission of the question of employee patent property rights seems particularly conspicuous. The question is one that lends itself to open discussion in West Germany, Holland, Denmark, Sweden, Austria, Switzerland, Italy and Japan; in all these countries there is national legislation of the apportionment type on employee and contractor intellectual property rights.

This problem is not, on the other hand, much discussed in the Soviet Union, East Germany, Rumania, Bulgaria, the Chinese mainland, Hungary, Canada, or the United States; in all these countries there is national legislation of the sequestration type on industrial inventions property. Rights in intellectual property in this group are determined pretty unilaterally, by government agencies or the managements of the larger industrial establishments or the stronger parties to various contractual arrangements.

Bernard M. Taylor, Jr.
Santa Monica, Calif.

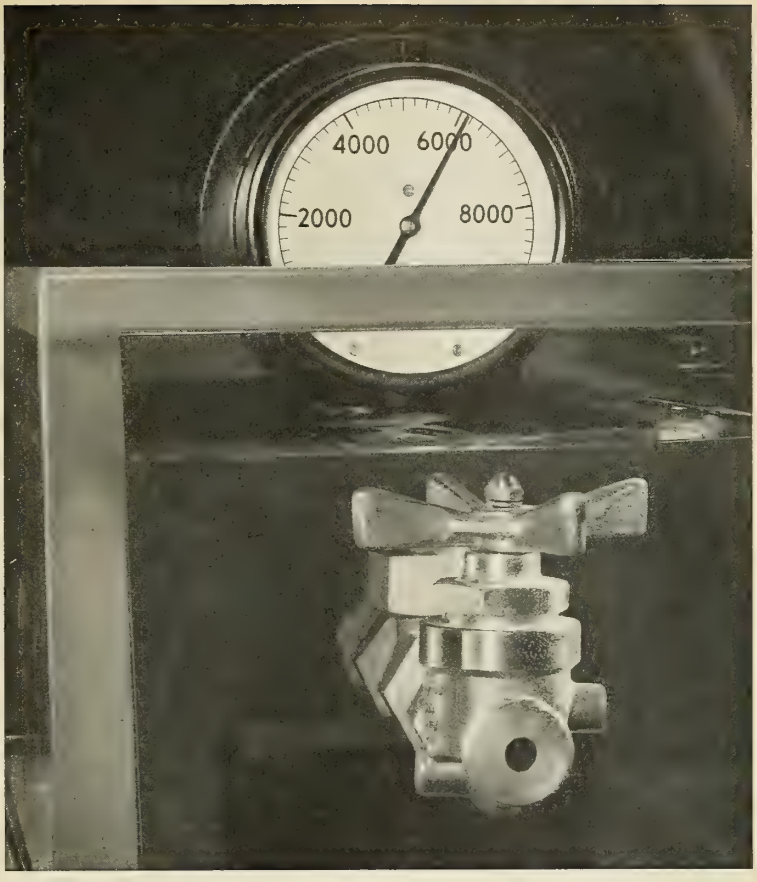
Clarification

To the Editor:

In the article, "Rails Proposed for Attitude Control" (M/R, Feb. 5, p. 34), concerning the pulsed plasma accelerator, there is a point of clarification with regard to capacitor life and electrode erosion that we should pass on for the information of your readers.

On the question of an energy storage capacitor, two capacitor manufacturers have told us they feel they can meet our specifications, so the capacitor apparently is not a major problem. However, since our discharge requirements are different than those of usual applications, additional work will be required to establish capacitor life and reliability. With regard to electrode erosion, the results of the life test were encouraging, and showed that electrode erosion was not the severe problem it was originally thought to be. However, the test was quite short and further work will be required.

Michel E. Maes
Research Engineer
Rocket Research Corp.
Seattle



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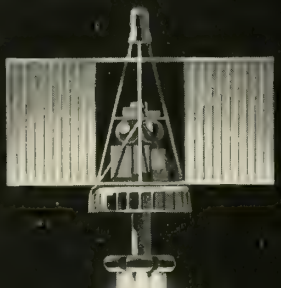

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The Countdown

WASHINGTON

The Outlook for ComSat

Administration officials are confident Congress will approve a compromise bill establishing a broadly owned communications satellite corporation. Senate Space Committee Chairman Robert S. Kerr (D-Okla.) reportedly has swung over to the Administration view that the general public should be permitted to own stock in the corporation. House Commerce Committee Chairman Oren Harris (D-Ark.) also is willing to go along, according to Hill sources. The compromise: plans for two classes of stock will be scrapped and only one approved. Price of the stock will be reduced and some provision to allow communication carriers to own ground stations will be written into the bill.

Too Big To Spend?

Some members of the House Space Committee believe it would be difficult for NASA to spend in one year all the funds it requested in the $3.7 billion FY '63 budget. As a result, look for the committee to approve cuts in the authorization for various NASA programs.

Webb Denies Political Rumors

Washington politicos were speculating last week that NASA Administrator James E. Webb might resign his post after the 1964 national elections to become chairman of the Democratic National Committee. Webb emphatically denies the reports, says he will continue to run NASA as long as President Kennedy wants him in the job.

DX Priority for Apollo Program

NASA's manned lunar landing program is expected to receive a DX priority soon from the President. The space agency applied for the highest national priority some time ago. White House sources indicate the request will be approved. *Apollo* will be a crash program only in terms of a highly accelerated effort, however—not in the sense of parallel development effort.

Navy To Attempt Airborne Launch

Navy was set last week for airborne launch of an undisclosed orbital payload from a McDonnell F4H out of Pt. Mugu. Project *Hi-Hoe* is a follow-on to the Naval Ordnance Test Station Project *Caleb*.

Orbital Space Platform for 1967-68

NASA plans to launch a permanent manned space platform at about the same time as the first manned lunar landings. Under present estimates for the *Apollo-C* mission, this would put the orbital platform in space about 1967-68. Air Force would like to achieve this much earlier.

AF Argument Gains Ground

One of the more potent Air Force arguments for an expanded man-in-space mission seems to be gaining ground with Congress. Military space vehicles, the AF points out, can be converted or diverted to civilian scientific missions—but the reverse is not true.

INDUSTRY

Centaur Launch Due This Week

The long-delayed initial launch of the liquid oxygen-hydrogen *Centaur* upper stage by an *Atlas* booster now is set for March 29. Heavier weight, meanwhile, has reduced *Centaur's* boosting capability and performance slightly. As a result, watch for NASA approval of a plan to use the *Surveyor* spacecraft propulsion "bus" as a third stage for *Advent* missions. *Advent* is now heavier. Prime *Centaur* contractors: General Dynamics/Astronautics, vehicle; Pratt & Whitney, propulsion; Minneapolis-Honeywell, guidance.

Retros Aid Titan II Separation

Martin's storable-fueled *Titan II* uses small solid rockets mounted in the forward section of the first stage to shove the booster away during separation. Several operations are performed simultaneously, including second-stage ignition. The holes, or windows, plainly visible in the stage-juncture area of the missile prevent a pressure build-up when the second stage fires.

Republic Seeking OSO Role

Republic Aviation Corp. will seek a major role in development of advanced versions of NASA's *Orbiting Solar Observatory*. Mock-ups of a Republic-designed second-generation *OSO* and associated guidance and stabilization equipment are being put together at the firm's Paul Moore Research Center in Farmingdale, L.I.

New Skybolt Destruct Development

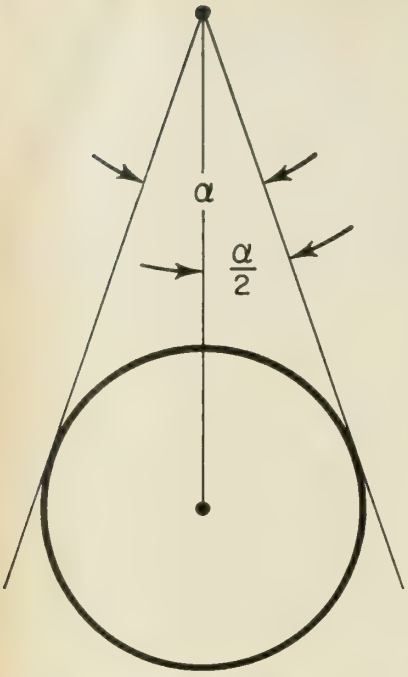
First tests are underway of a new device to prevent inadvertent destruction of Air Force's *Skybolt* air-to-surface weapon system. The command destruct module, developed by Thompson Ramo Wooldridge, employs a unique Raytheon filtering network which acts like a safe combination—only a certain set of five RF signals can set off the destruct mechanism in the missile. The system is intended to head off problems caused by stray radio signals.

Reason for ANNA Classification

ANNA, a joint geodetic satellite managed for the military services and NASA by the Navy, is being criticized on the ground that an essentially civilian application is cloaked in military security. Behind the classification: development problems the Navy has had with the system. These appear to have been ironed out and the Navy promises details on *ANNA* "soon"—probably after its upcoming launch as part of a composite payload on a *Thor Able Star*.

INTERNATIONAL

The Soviet Union is spending less on space than the U.S. in terms of absolute dollars, according to Dr. Edward C. Welsh, executive secretary of the National Aeronautics and Space Council. In terms of a percentage of gross national product, the two nations appear to be spending about the same amount on space exploration.



ge·o·me·try

Greek **geo·metrein,** from **ge,** earth; **metrein,** to measure

PROBLEM: (Euclid, ca. 300 BC): From a point outside a circle, using only straight edge and dividers, construct a line through the center of that circle.

SOLUTION: (Barnes Engineering Company, 1962 AD): By means of an **infrared straight edge,** the two tangents from the point to the circle are constructed, giving the subtended angle α. By means of **electro-optical dividers,** the angle α is bisected. The bisector is the required line. QED.

COROLLARY: If the point is a space vehicle and the circle is a plane through the earth, the bisector is the local vertical in that plane.

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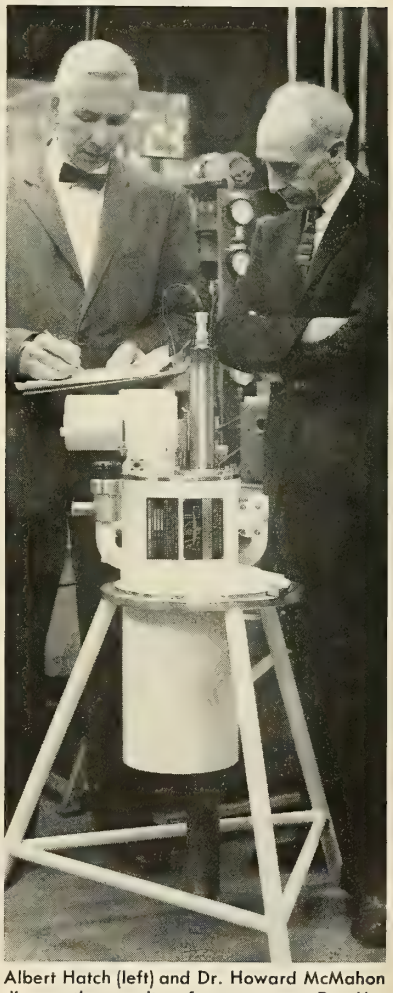

Albert Hatch (left) and Dr. Howard McMahon discuss the results of a test run. Dr. McMahon and William E. Gifford, now Professor of Mechanical Engineering at The University of Syracuse, were co-inventors of the refrigeration cycle used in the CRYODYNE Refrigerator. Albert Hatch is in charge of engineering development of the Refrigerator at ADL.

Closed-cycle refrigeration at liquid helium temperatures is now available in proven hardware. Arthur D. Little, Inc. — under the initial sponsorship of International Business Machines Corporation and continuing sponsorship by the U.S. Army Ordnance Corps through Bell Telephone Laboratories, Inc. — has extended the development of its patented Gifford-McMahon cycle to produce the ADL CRYODYNE HELIUM REFRIGERATOR. The Refrigerator will provide up to 250 milliwatts of refrigeration at liquid helium temperatures and will function normally regardless of physical orientation. A number of units were completed in 1961 and by December 31st had accumulated, in aggregate, more than 10,000 operating hours. A CRYODYNE Refrigerator on one endurance test run exceeded 1500 hours of continuous operation without maintenance or control manipulation.

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DOD Revises Procurement Policy

The Defense Department last week formally revised its procurement regulations to provide contractors with greater incentives to control costs and improve performance.

Heart of the new policy, said Deputy Secretary of Defense Roswell Gilpatric, will be the greater use of firm fixed-price and incentive contracts and the de-emphasis of cost-plus-fixed-fee awards.

Noting that the average profit on CPFF contracts is a little over four percent, Gilpatric said that the new incentive policy would enable contractors to earn profits up to the statutory limit of 15%.

Conversely, poor performance will be penalized. Although initially the profit swing will be from four to 11 percent, DOD eventually hopes to increase the swing from zero to the 15% limit in order to make the system work.

The revised regulations, Gilpatric noted, had been sent in draft form to industrial firms and associations throughout the country. The detailed comments and objections received were taken into consideration in the final language of the procurement regulation revisions.

Although firm fixed-price contracts are still preferred by DOD, Gilpatric admitted that, due to the nature of Defense awards, it is unlikely that this type of award will increase significantly in the future.

The incentive pact, therefore, will enable the government to reward efficiency while punishing poor performance.

Criteria for evaluating a contractor's performance will rest on three key areas: cost control, performance of the final end product and its ancillary subsystems, and the reliability and development time of the final item.

The revised regulations become effective upon receipt by procurement agencies or on June 15, 1962—90 days after issuance.

NASA Budget Faces Knife

A top House Democrat predicts that NASA's Fiscal '63 budget will be slashed by Congress.

"I think it is the sentiment of Congress that the budget should be reduced," Rep. Olin Teague (D-Tex.), second-ranking majority member of the House Space Committee, told MISSILES AND ROCKETS.

Teague, who also serves as chairman of the Manned Space Flight Subcommittee, said that "I think they (NASA) have done well, but I also think many members of Congress feel that they just can't spend $3.7 billion in one year."

If, as is indicated, the House committee reduces the NASA Fiscal '63 authorization legislation, the cuts will be made in specific programs. There is also a chance that this could be reduced even further when the Appropriations Committee begins its consideration of the budget.

Meanwhile, NASA officials told the Unmanned Space Flight Subcommittee that the first launch of *Centaur* would come in the very near future.

Informed sources reported that the shot was scheduled for March 29.

The suborbital flight will have a trajectory of 1175 miles, with the *Centaur* burning up as it re-enters the atmosphere.

The flight is expected to provide information on two main points: the behavior of hydrogen during zero "G," and whether or not the *Centaur* engines will ignite in space.

Col. Donald Heaton, director of launch vehicles in NASA's Office of Space Sciences, told the subcommittee that two main problems still must be solved in the *Centaur* development. One is the difficulty in learning how to pump hydrogen into the vehicle's tanks. The other is the development of cracks in a bulkhead producing seepage which allows the hydrogen to turn into gas.

He also disclosed that the program—which has cost $350 million to date—is one year behind schedule, with the first operational vehicle not slated until early 1964.

He said the second and third *Centaur* vehicles are now undergoing tests at Edwards AFB, Calif.

Mercury Chief Gilruth Wins Goddard Trophy

ROBERT H. GODDARD Memorial Trophy, founded by MISSILES AND ROCKETS *Magazine, was awarded to Robert R. Gilruth, Director of NASA's Project Mercury, at National Rocket Club dinner March 16. Vice President Johnson made presentation. Mrs. Goddard is at center, NASA Administrator Webb at right, M/R Editor Coughlin at left.*

Minuteman Award Announced

A $61-million contract for the construction of a *Minuteman* ICBM base near Whiteman AFB, Knob Noster, Mo., was announced by the Air Force last week.

Four firms — Morrison-Knudsen, Paul Hardeman, Inc., Perrini Corp., and C. H. Leavell and Co.—will team up to build the 150-missile base. The Whiteman complex is the fourth *Minuteman* base under construction.

Shots of the Week

Titan II—the most powerful ICBM under development by the U.S. —was successfully launched from Cape Canaveral March 16.

SPACE SIMULATION

...and the ADL-Collins Helium Cryostat

The ADL-COLLINS HELIUM CRYOSTAT has been proven in extensive field operation to be an economical and effective means of producing high-vacuum cryopumping for space simulation experiments. Three models of the Cryostat are available for work in this area. The Refrigerator Model is used for cooling and circulating 8°-30°K helium gas through a closed-cycle system to a condensing surface within the simulation chamber. The standard Cryostat will produce up to eight liters/hr. of liquid helium which in turn may be used in a variety of ways to produce cryopumping. The third Cryostat model is designed for liquefaction of gases other than helium — most commonly hydrogen. Cryopumping, utilizing either low-temperature gas or liquid, offers extremely high pumping speeds at high vacuum — a vital consideration in any experiment involving an appreciable degree of outgassing. For more detailed Cryostat information, write: RESEARCH EQUIPMENT, Arthur D. Little, Inc., 20 Acorn Park, Cambridge 40, Mass.

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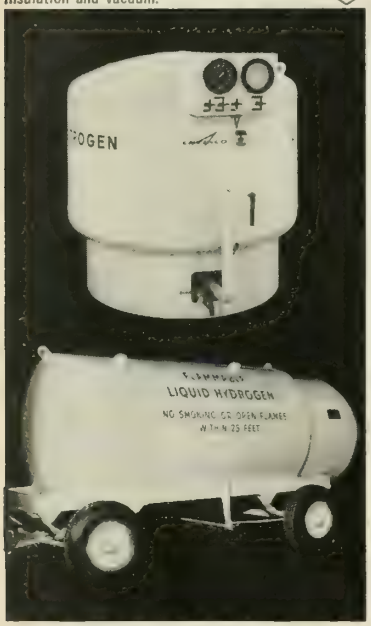

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All of these high efficiency dewars, as well as many more, are standard production units. Special dewars include units such as a high efficiency 100 liter liquid helium dewar with a liquid nitrogen shield–1% He and 3% N_2 heat leak per day. Another special project is an 8,150 gallon liquid helium trailer, now under thermal tests.

At CRYENCO, quality is a creed! These efficiency ratings show it. For your standard or special dewar requirements, write for CRYENCO Dewars data sheets.

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Low Temperature, High Vacuum Equipment and Engineering

The Missile/Space Week

The first flight test of the 103-ft., 430,000-lb.-thrust ICBM covered more than 5000 miles and accomplished all the major test objectives, the Air Force announced.

In addition to evaluating the propulsion system, staging technique and flight performance, the test established the basic integrity of the overall design and various subsystems.

To be launched from an underground silo, *Titan II* is designed for a quick reaction time. It therefore uses storable hypergolic propellants which produce a glowing hot gas rather than a flame.

The successful flight was also the first test of the Mark VI re-entry vehicle—one of the largest ever flown on an ICBM—built by the General Electric Company.

• The Army's *Pershing* missile was successfully launched from Cape Canaveral March 15.

The missile's prototype ground support equipment was used for the first time in the firing, to evaluate its performance and its ability to withstand the blast and heat of the missile's launch.

The three GSE units—the Transporter-Erector-Launcher, the Programer Test Station and the Primary Power Pack—met all the test objectives, according to the Army.

• Although successful, a *Nike-Cajun* rocket fired from Eglin AFB, Fla., March 16 to measure infrared rays in the atmosphere caused some consternation when the *Nike* booster fell in a vacant lot between two houses in nearby Venice, Fla.

Two K's Talk Space Cooperation

President Kennedy's letter to Premier Khrushchev—made public last week—lists five specific proposals for cooperation in space:

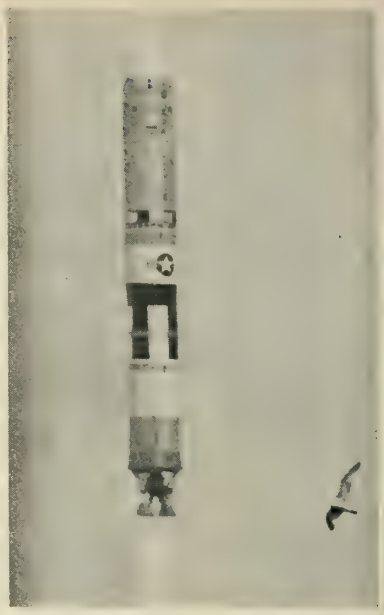
—Establishment of an early weather satellite system with each country launching its own satellite into polar orbit in planes approximately perpendicular to each other.

—Establishment of radio tracking stations in each other's territory to be operated by indigenous personnel.

—Establishment of a project to map the earth's magnetic fields.

—Cooperation in the development of communications satellites.

—Cooperation in the field of space medicine through the exchange of information.



First Flight of Titan II

AF'S Martin Titan II storable-fueled ICBM was launched successfully from Cape March 16—to apparent unconcern of passing seagull.

Stressing that the list of projects was not "intended to limit" the consideration of cooperative projects, the President carefully avoided any programs that might encroach on Soviet territory or security.

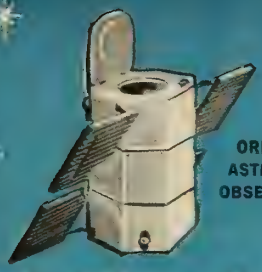
The letter—sent to the Soviet Premier two days after his congratulatory message on John Glenn's orbital flight—was not previously released because of the Administration's desire to give Khrushchev an opportunity to study its contents.

Meanwhile, the 28-nation U.N. Committee on the Peaceful Uses of Outer Space was meeting in New York for the first time in full session. Previously, the Russians and the Iron Curtain countries had boycotted the committee.

U.S. Delegate Francis T. P. Plimpton told the opening session that "there are hopeful prospects of collaboration between my country and the Soviet Union in Outer Space projects."

Soviet delegate Platon D. Morozov echoed this by saying that the Russians were ready to cooperate in the exchange of information, tracking projects and the study of legal and technical problems connected with space.

Khrushchev, however, in a note to the President last week, linked space cooperation "in some degree on the solution of the disarmament problem."



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ASTRONOMICAL
OBSERVATORY

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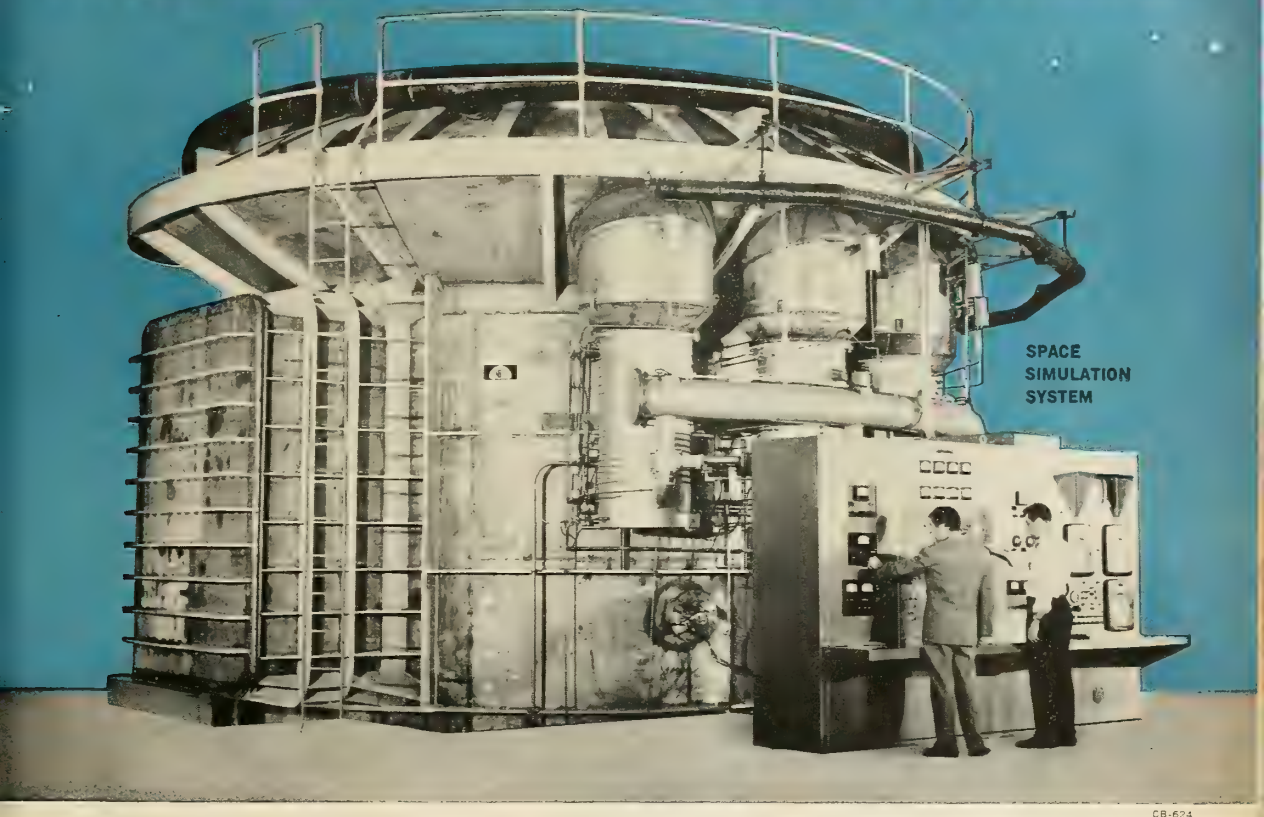

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CB-624

...temperatures from +350°F to -320°F
...vacuum to 1 x 10^{-7} mm Hg

How do you perform the necessary preflight thermal vacuum tests of the OAO (Orbiting Astronomical Observatory) to assure reliability? That was the question faced by Grumman Aircraft Engineering Corporation, prime contractor to NASA for the OAO.

The 19 ft. dia. by 26 foot test chamber above is the heart of the space simulation system designed and built by CB&I. The high vacuum pumping system can lower pressure below the 10^{-7} mm Hg range. The low temperature of outer space can be simulated by a liquid nitrogen cold wall. The nitrogen systems also include equipment to heat and circulate gaseous nitrogen for thermal testing, and a vaporizer-super heater for emergency heat-up of the nitrogen shroud.

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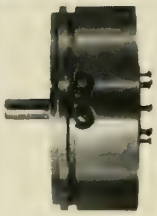

OPTISYN high-accuracy incremental optical shaft-angle digitizer. Standard sizes 11 to 27.

OPTISYN, instead, achieves high-efficiency wide-aperture optics through the use of a rotating moiré interference pattern. The result is valuable error compensation and such high light-path efficiency that a-c or d-c light sources can be run at *reduced* excitation. This gives OPTISYN long life (a projected 6 years mean-time-to-failure), and ruggedness to meet MIL-E-5272C.

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VARIATIONS? Special designs, including pancake shapes, are in production for inertial accelerometers, gyro gimbals, pedestal mounts, industrial uses, etc. Output electronics also available to match high-performance OPTISYN into your digital system. Want more information?

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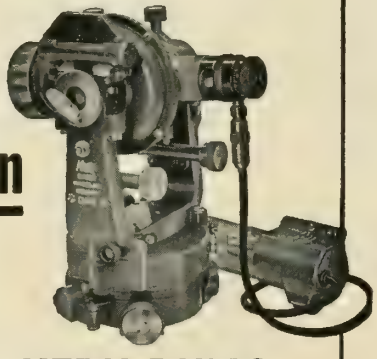

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The Missile/Space Week

Red Boasts 'Global Rockets'

Premier Nikita S. Khrushchev rattled a new "Global Rocket" at the West last week in a campaign speech to Moscow voters.

The new weapon, the Soviet Premier said, "can fly around the world in any direction and strike a blow at any set target."

Lockheed Sees Huge Markets

Lockheed Aircraft Corp. predicts in its 30th annual report that aerospace and other defense markets will hit $25 billion a year by 1970.

"These markets . . . include large increases in research and military and civilian space programs; continued large purchases of manned military aircraft, missiles, and ships; and a higher volume of electronics," Chairman Courtlandt S. Gross and President Daniel J. Haughton told shareholders.

The bold forecast was made as Lockheed reported new highs in earnings, sales and backlog for 1961, reversing losses of 1960 when the firm recorded large writeoffs on transport programs.

Rocket Club Honors Gilruth

Robert R. Gilruth, Director of NASA's Manned Spacecraft Center, was presented the Dr. Robert H. Goddard Memorial Trophy at a wind-up dinner of the National Rocket Club's two-day National Space Conference.

Cited for his "personal dedication in leading the Project *Mercury* team," Gilruth was presented the trophy by Vice President Lyndon B. Johnson.

Winners of other awards:

—William G. Stroud of the Goddard Space Flight Center, for his contributions to development of meteorological satellites and their associated equipment, received the Astronautics Engineer Award.

—Astroelectronics Division of RCA, for its work on the *Tiros* meteorological satellite, received the Nelson P. Jackson Memorial Aerospace Award.

—The *New York Times,* for its day-to-day coverage of the aerospace field, received the National Rocket Club Award.

—Allen M. Lenchek received, for the second straight year, the Dr. Robert H. Goddard Memorial Scholarship Award.

Russians Launch New Sputnik

In an off-hand remark during a marathon campaign speech, Soviet Premier Nikita S. Khrushchev revealed that the Russians had launched another *Sputnik* March 16.

Although orbital data on the spacecraft was not immediately available from either Soviet or American sources, Tass later confirmed the launching and released the following orbital data: apogee, 608.94 miles; perigee, 134.83 miles; period, 96.35 min.; angle of inclination to the equator, 49 degrees and transmitting frequencies, 20.003 and 90.018 megacycles.

First of a series of satellite launchings scheduled for 1962, according to Tass, the earth satellite will study "the upper layers of the atmosphere and outer space."

Specific objectives of the Soviet satellite program, as outlined by Tass, are studies of:

—Concentration of charged particles in the ionosphere for investigating propagation of radio waves.

—Corpuscular flows and low-energy particles.

—Energy composition of the radiation belts for evaluation of the radiation danger in prolonged space flights.

—Primary composition and intensity variations of cosmic rays.

—Magnetic field of the earth.

—Shortwave radiation of the sun and other celestial bodies.

—Effects of meteoric matter on construction elements of space vehicles.

The off-hand announcement of the launch, as well as the lack of early orbital data, gave rise to conjecture that the Russians had launched another manned vehicle or an applications satellite.

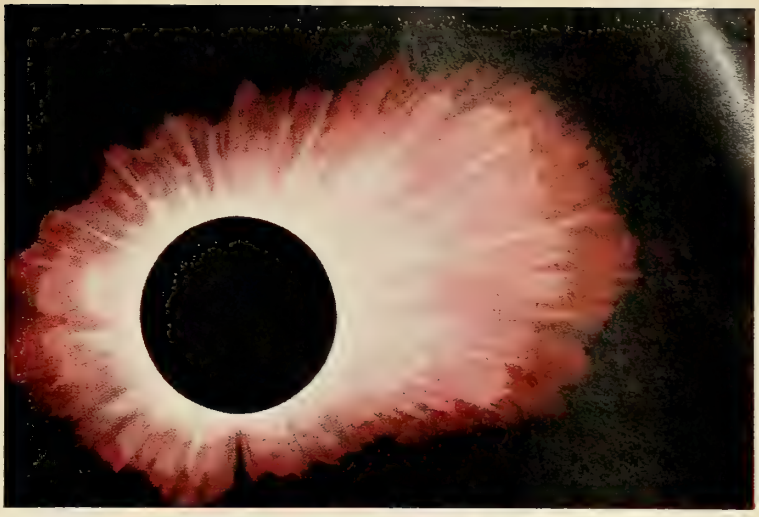
However, as minute bits of information were released by both Tass and the U.S., it became clear that the new *Sputnik* was an extension of the Soviet space research program.

Least encouraging aspect of the launching was the apparent failure of the U.S. *SPADATS* to pick up the orbiting craft on its initial orbit.

NASA Seeks $618.5 Million For Research/Technology

NASA reported to a House Space Subcommittee a $618,500,000 request for Fiscal Year 1963 for advanced research and technology, including $52,588,000 for aircraft and missile technology to advance studies on a

(Continued on page 25)



SOLAR ENERGY WHERE THERE IS NO SUN?

Man is accustomed to the age-old concept of night and day. Long hours of sunshine, equally long hours of darkness. Not so, during Earth Orbit, in the unexplored regions of outer space, when life-giving rays of the Sun are eclipsed for a brief period every hour. Though momentary, these periods of darkness threaten the feasibility of Solar Powered space vehicles. This is but one of the many challenges confronting Ken Nichols and his associates at Sundstrand Aviation-Denver. Ken is Project Manager, guiding the development of a 15 KW (electrical) Solar Dynamic Space Power System under Air Force Contract. ■ Briefly, the system is comprised of a huge mirror which reflects solar energy into a boiler. Here, under intense heat, liquid metal is vaporized, thus powering an axial flow turbine which drives a generator floating on liquid metal bearings. Sundstrand had to devise a method for continuing the generation of power, when solar energy was blotted out by the Earth's shadow. In some Earth Orbits, night would last only a short period of time. Even so, energy must be stored during this brief period in order to sustain electrical power aboard the vehicle. Ken and his fellow workers believe they've solved the problem. They are testing a system which utilizes the phenomenon of the latent heat of fusion. Salts of some metals, when changing from liquid to solid state, release large amounts of thermal energy. This heat provides for continued accessory power where there is no sun. The Solar Mechanical Engine is but one of four important Space Power Systems for which Sundstrand has been given the responsibility of development. ■ Each day, engineers at Sundstrand are confronted by such vexing problems as the containment of highly corrosive liquid metals, finding adequate methods for operating in Zero G environment, and liquid metal journal bearing performance. ■ Still, never let it be said that Sundstrand employees live with their heads in the clouds. They appreciate the permanent, ideal working conditions . . . Colorado's exceptional recreational opportunities . . . the friendly, congenial Mile-high surroundings. And most of all, they are enthusiastic about the myriad challenges that confront them daily. Each has the satisfaction of knowing that he is taking an active part in the conquest of space. ■ If YOU are a qualified space age engineer or technician and would like to meet the challenges of tomorrow, act today! Apply in person or send a resume of qualifications to:

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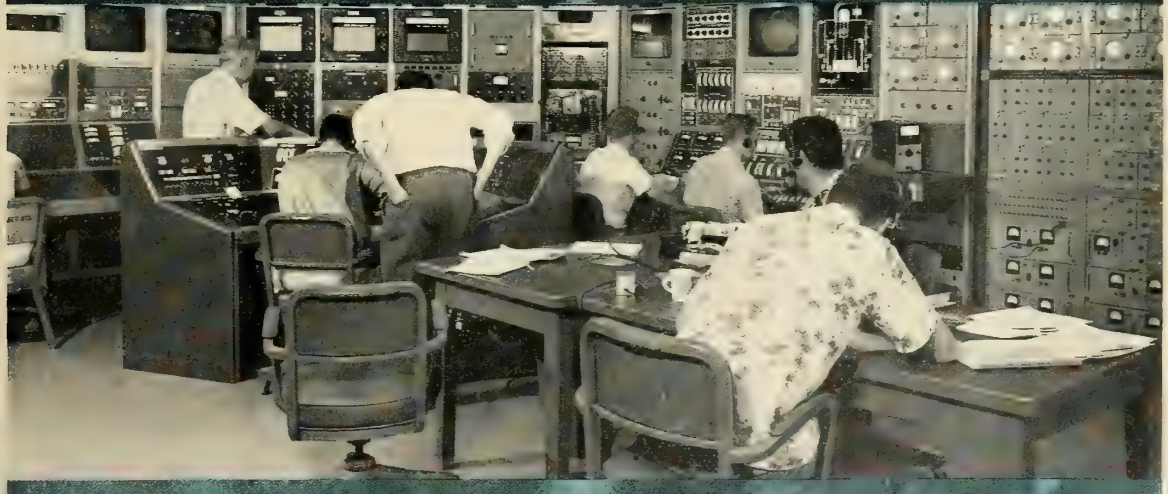

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We will make specific recommendations and provide design changes to bring your equipment within the RFI specifications or inform you if it is already within standards. Capehart's INTERDICT Group performs this same service for any other type of installation, site or system where RFI may be a potential problem. Our approach in RFI diagnosis of over-all operational requirements utilizing computer programming has been proven on a number of electronic equipments, missile systems and military sites including Cape Canaveral and Vandenberg AFB.

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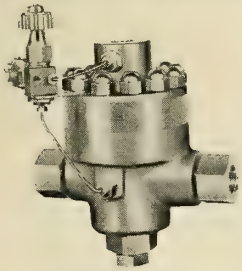

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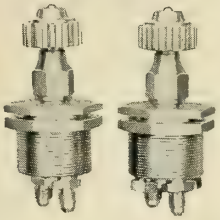

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Stainless steel or bronze with stainless trim.

For panel mounting. Inlet: 10,000 psig.

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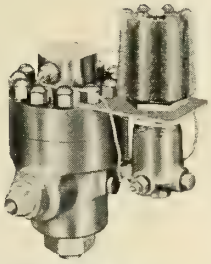

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Stainless steel — Inlet: 10,000 psig.

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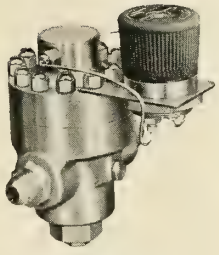
Provides accurate, safe, pilot regulator-type control.



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Bronze, stainless steel, aluminum.

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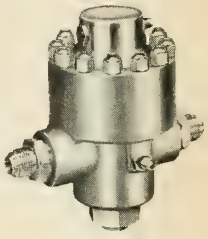
Provides simple, finger-tip valve control. Loads 30° clockwise; bleeds 30° counter-clockwise; returns to neutral automatically.



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SPECIFICATIONS

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Materials: Bronze, stainless steel, or aluminum.

Characteristics: Compensated type, constant outlet pressure.

Actuation: Dome loaded.

Inlet pressure: 6,000 psig.

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Operating temp.: −67° F. to + 160° F.

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Leakage: Zero.

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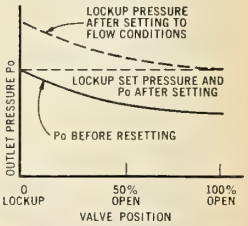
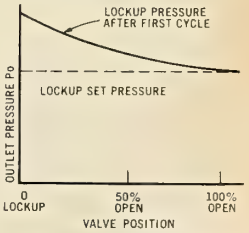


Compensated gas-o-dome regulator operated with load & bleed valves or LV10 loader valve



Compensated gas-o-dome regulator operated with loader regulator

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Monsanto®

Missile/Space Week

(Continued from page 19)

supersonic commercial transport and a military V/STOL aircraft.

Here is the breakdown: 1) Aircraft and Missile Technology: Advanced research, Supersonic commercial transport—$18 million, V/STOL aircraft—$4.5 million, Multicapacity aircraft—$4.5 million, Hypersonic aircraft—$3.0 million. Advanced Technical Development—$9.5 million, Flight programs, B-58 flight simulation of supersonic transport operations—$1.6 million, B-70 flight simulation of supersonic transport operations—$1.5 million, *X-15* hypersonic environment studies—$8.0 million, V/STOL aircraft—$1.9 million.

2) Spacecraft Technology: Advanced research and technology—$30.9 million, Flight programs—$23.2 million.

3) Launch vehicle technology: Advanced systems studies—$7.4 million, Vehicle technology—$24.2 million.

4) Launch Operations Development: Launch operations studies—$2.9 million, Advanced instrumentation—$0.3 million, Range support operations—$18.2 million.

5) Nuclear Systems Technology: Advanced research—$15.3 million, Advanced technical development—$73.7 million, Flight programs—$33.9 million.

6) Electronic propulsion: Advanced research—$12.1 million, Advanced technical development—$10.7 million, Flight programs—$7.7 million.

7) Liquid propulsion: 1.5 million-lb.-thrust engine (F-1)—$55.3 million, 2-million-lb.-thrust hydrogen oxygen engine (J-2)—$38.7 million, Analysis and supplemental systems—$13.7 million.

8) Solid propulsion: Systems and components development—$7.9 million.

9) Space Power Technology: Advanced research—$6.9 million, Advanced technical development—$13.2 million.

Space Watch Extended to Moon

A surveillance system to catalog space objects both natural and man-made between nominal, low-altitude orbital areas and the moon is being developed by the Air Force's Space Track Research and Development Facility at Hanscom Field, Bedford, Mass.

Dr. Eberhard W. Wahl, acting chief scientist for the project, says the system "will have to track any natural 'moonlets' because until we establish an inventory of everything in orbit, we cannot tell if something has been added."

The new surveillance system, Wahl said, would log the position and orbit of any satellite "so that if an unannounced satellite not sent up by the United States were discovered, SPADATS can say with certainty, 'This is a natural moonlet—or this is a foreign satellite.'"

Profits Quiz Set for April

The long-awaited McClellan Committee probe into excess profits growing out of missile and space contracts will open with public hearings on April 3.

The Senate Investigating subcommittee is expected to hear Army and Air Force testimony on present procurement practices as well as apparent "unnecessary and excessive costs" associated with missile contracts.

Among those expected to testify are representatives from: Aerojet-General Corp., the Boeing Co., Consolidated Western Steel Div. of United States Steel Corp., Douglas Aircraft Co., FMC Corp., Fruehauf Trailer Co., General Dynamics/Astronautics, International Telephone and Telegraph Corp., Lear, Inc., Thiokol Chemical Corp., Western Electric Co., Westinghouse Electric Corp.

Slayton Decision Criticized

Astronaut Donald K. Slayton has been removed as pilot of the *MA-7 Mercury* flight because of a minor heart defect.

It is still possible, however, that he will be available for later manned space flights.

NASA announced March 15 that Slayton had been ruled out as pilot for the next *Mercury* three-orbit flight.

The space agency said he would be replaced by Astronaut M. Scott Carpenter, who served as backup pilot for John Glenn, Jr., in the first orbital flight on Feb. 20.

NASA said that the heart defect was first discovered in December, 1959, during one of the periodic medical examinations given all the astronauts.

It was decided at that time, the space agency said, that Maj. Slayton should continue in the program but that "the condition should be monitored closely."

The condition was described as

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an "erratic heart beat." It was reviewed by an Air Force medical team and a group of civilian cardiologists who agreed that Slayton should not make the flight.

Deputy Administrator Dr. Hugh L. Dryden said Slayton was kept in the program because medical authorities earlier believed that the condition would not interfere in the performance of his duties.

As the date for Slayton's flight approached, Dryden said, responsible officials had to face up to the possibility of failure during the flight and decided to take no chances.

Dryden's comments did little to blunt the criticism hurled at NASA because of the incident.

Much of the criticism was centered on the belief that NASA should not have waited to make the decision until after Slayton had been named to make the flight.

The *MA-7* mission is still tentatively scheduled for early May.

Vacuum Test Facility Expanded

Nine space chambers capable of reaching 10^{-10} torr and ranging in size from 3 to 50 ft.^{3} are in operation at National Research Corp.'s Space Vacuum Lab. This multiple test ability, first of its kind in the U.S., permits valid comparisions of systems in addition to a capability of handling several systems at once.

Thermal cycling, solar radiation, motion, cryogenic and extremely high temperatures can be introduced. NRC is working on a new chamber aimed at reaching lower pressures than any current test facility.

Laser "Moon Bounce" Planned

Scientists at the University of Michigan have announced plans to attempt to bounce a Laser beam off the moon and pick up its reflection, if any, back to earth.

Using a synthetic ruby laser, the needle-thin beam of light hopefully will make the round-trip to the moon and back in 2½ seconds, having bounced off one of the moon's highly reflective craters, in the process.

The experiment, according to Peter A. Franken, Physicist on the University staff, is a prelude to bouncing Laser beams off orbiting satellites to study such things as the speed of light and radio waves in a vacuum.

The experiment is scheduled to get underway in a week or so, Franken said.

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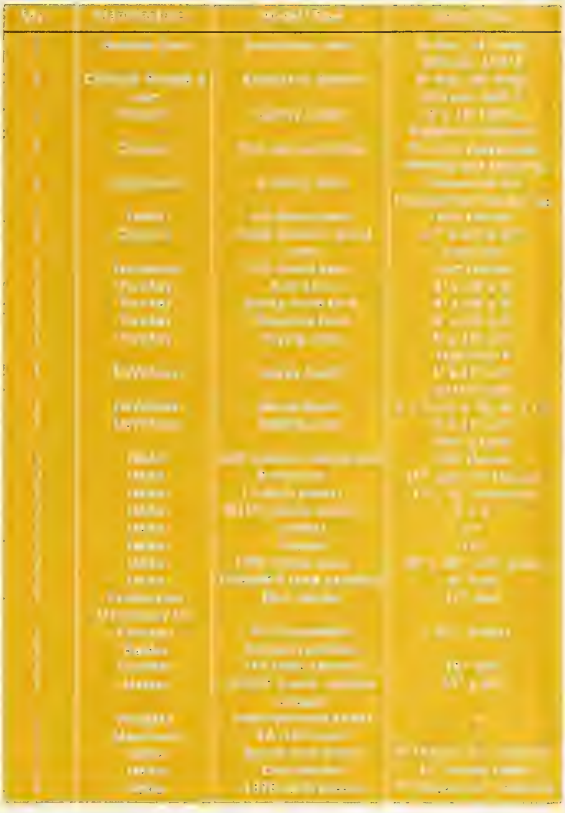
GENERAL DYNAMICS | CONVAIR HONEYCOMB AND METAL BOND MANUFACTURING

Rigid control and precision craftsmanship are inherent in Convair's production of honeycomb and metal bond panels. The operation includes all processes from honeycomb core machining to detail prefitting, surface treatment, controlled environment layup, pressing and autoclaving. Aluminum honeycomb core, and cores of foam with aluminum sheet, glass fabric laminate and sheet plastic for facings, are fabricated for primary and secondary structures as well as for trim and decorative applications. After routing and milling, polyglycol is poured into the cells to stiffen the core. The machining area is also equipped with a specially designed band saw for contouring large blocks of honeycomb core. Kits of prefitted assemblies undergo surface treatment, priming, and complete preparation for curing before being autoclaved or press cured. The entire manufacturing area is kept free of contamination by compressed air and a large-volume vacuum system.

Equipment essential to Convair's production of honeycomb and metal bond is listed at right

HONEYCOMB AND METAL BOND EQUIPMENT (33)



Aluminum parts are primed for curing in this large spray booth adjacent to the surface treatment tanks. Water spray in the background circulates continually to eliminate fumes.

A honeycomb panel, under a protective covering, enters one of two gigantic autoclaves for the pressure curing process.

An efficient overhead handling system facilitates the movement of aluminum parts through surface treatment tanks.

Illustrated on front cover:
Horizontal band saw, built to Convair's specifications, for delicate contouring of honeycomb materials.

(left)
Aluminum honeycomb panels are handled with white gloves during layup to protect the intricate and sensitive structures from perspiration and body oils.

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These subcontract capabilities are described in other brochures available from:

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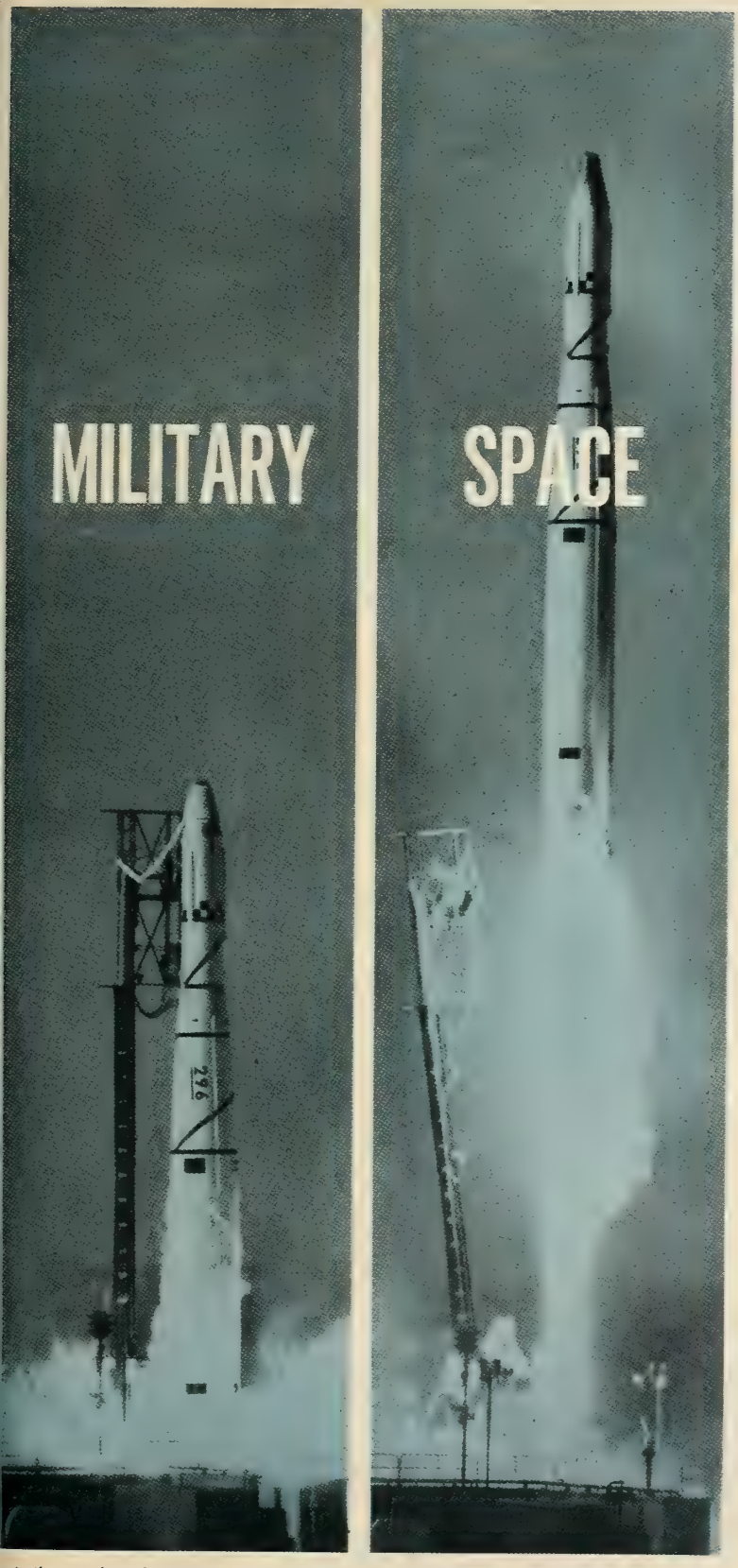


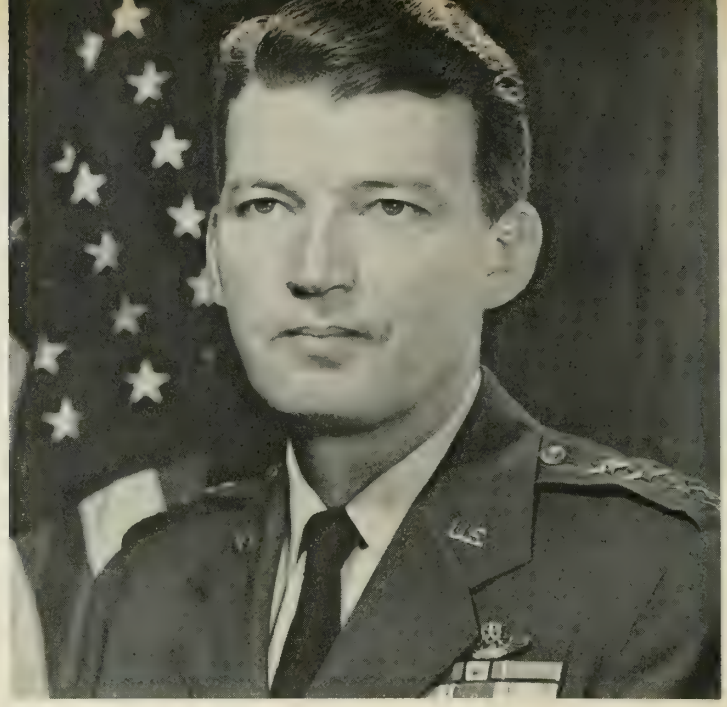
MILITARY SPACE SYSTEMS

Streaking upward, the military space budget accounts for the biggest single increase in Dept. of Defense spending this next year. In this special issue, Missiles and Rockets surveys the nation's military space capability.

Part I, *a look at the budget and plans for the military space systems of the three services . . . details of spacecraft under development and planned for the future . . . a survey of the latest developments in electronics, materials, auxiliary power units, propulsion and bioastronautics . . . reports on military procurement and cooperation between Dept. of Defense and the National Aeronautics and Space Administration.*

Part II, *a report on the nation's military space centers, begins on p. 87.*

LAUNCH OF A DISCOVERER— Part of a series regarded as representing one of most successful U.S. efforts to date.



THE AIR FORCE SPACE MISSION

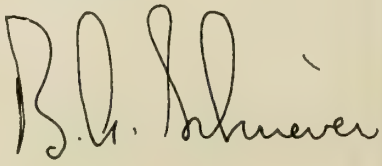
SPACE TODAY is mankind's newest frontier. It is a vast realm that offers the promise of untold benefits. It challenges us not merely to discover new knowledge but also to insure that this knowledge is used wisely for the benefit of all mankind.

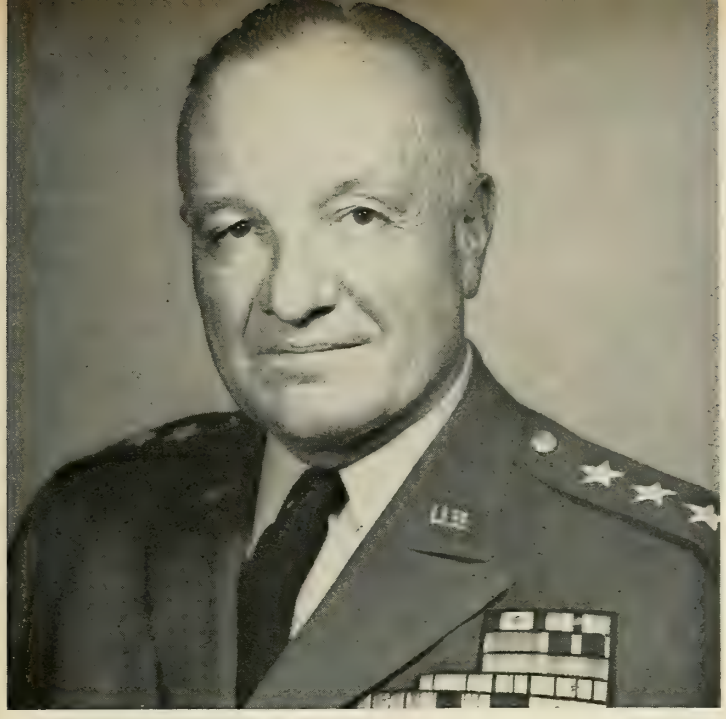
To meet this challenge the United States must give every encouragement to the rapid advance of space technology and its adaption into operational space systems, both unmanned and manned.

The urgency of the task to be done in space requires the greatest wisdom in the use of personnel, facilities, and technical knowledge.

The conduct of future military operations in space depends on developments in a number of specific technological areas. These include launch vehicles; propulsion in space; aerospace medicine; environmental data; rendezvous, docking, and transfer; in-space power supplies; sensors; communications; re-entry and recovery techniques; weapons; and command and control.

Through its programs in these areas of technology the Air Force Systems Command carries out its mission of forging military spacepower. At the same time its continued close cooperation with the National Aeronautics and Space Administration and other government agencies helps insure the timely attainment of all our national objectives in space. ■





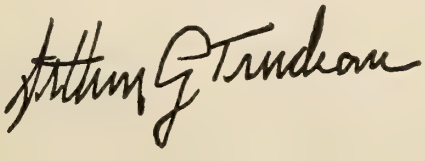
THE ARMY'S ROLE IN SPACE

NEVER BEFORE in history has there been a field of endeavor so potentially crucial to the fate of man as our race with the Communists for space supremacy. Upon our winning this race rests the hope of free men everywhere. Our mighty nation can and will surpass the Communists in space. We will do it in a team effort by NASA and all of the military services. It will take the combined talents of all to accomplish this task.

The Army, as a partner on this team, has historic interests in exploration, dating back to the opening of the West. Despite the advent of air vehicles, irrefutable is the fact that new frontiers can only be controlled and developed by man on the ground, mapping, clearing and building. Although modern technology has facilitated his task, it has not replaced him.

The Army retains clear capabilities on the ground or surface, which can contribute mightily to the national space effort. Indeed, the first American to land on the moon or a distant planet may hold in his hand a map prepared by our Corps of Engineers, he may communicate with earth through systems developed with Signal Corps assistance. The development of the food he eats, the clothing he wears, the shelter he uses, and the means of surface conveyance can well be the contribution of the United States Army.

There is no better way to make manifest our great national spirit than to unite all Americans in calling forth and integrating our vast resources, our limitless talents, our incomparable ingenuity, in meeting and mastering the Communist challenge in space. ■



NAVY MISSION IN SPACE

THE MISSION of the Navy is to provide the United States an effective capability to project our national power swiftly to all parts of the world and conduct sustained operations in any ocean. Ships, aircraft, missiles, and people are the vital ingredients that make up our powerful Naval Forces.

The use of space will inevitably increase the Navy's ability to do its job better. We are about as far advanced into the space age now as we were 50 years ago in the aviation age. Everyone is aware of the tremendous increase in capability that resulted from the use of the aircraft by the Fleet. We expect a comparable increase to result from our use of space in the future.

With respect to the Department of Defense activities assigned to the Navy, there are several that should be mentioned. One is the Pacific Missile Range, managed by the Navy, which supports in one way or another most of the missile and space projects in the United States, both civilian and military.

Under Project *LOFTI*, the Navy conducts communication experiments in the very-low-frequency range. The Navy space surveillance system *(SPASUR)* is a vital component of the North American Air Defense Command. *SPASUR* keeps track of all the satellites and space "junk" which cross this country.

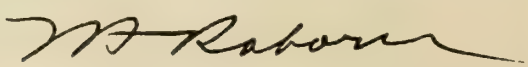
The Navy participates actively in the United States meteorological satellite programs, operating one of the terminals of the *Tiros* system at the Pacific Missile Range. The Navy is coordinating closely with NASA to insure that Naval ships will have direct read-out from weather satellites.

In the scientific area, we have the Solar Radiation and the *Injun* Programs, by which we conduct a broad program of space-environment research.

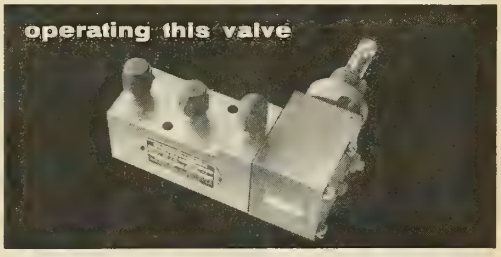
One of the great advantages of sea power is mobility. The Navy is conducting work in developing sea-launching techniques (HYDRA) and studies in shipboard launching techniques.

The Navy continues its contributions to navigation through Project *Transit*. The Navigation Satellite will provide world-wide day and night high-precision navigational information when it becomes operational in fiscal year 1963. Two *Transit* satellites have used our first nuclear power supply in space, the *SNAP III* Isotopic Thermoelectrical Generator.

Looking toward the future, the Navy intends to influence the design characteristics of proposed national space systems to meet naval requirements. We also will continue to conceive and propose for development by the Navy those space systems serving a predominant Navy requirement or utilizing unique Navy talents or capabilities. ■



In orbit on February 20, 1962
the attitude of Friendship 7, was controlled manually



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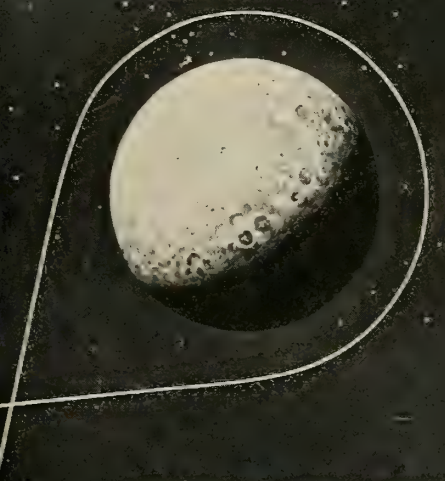

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Budget May Outstrip NASA's by '70

Unofficial industry estimates put DOD space funding at $30 billion over decade; Air Force, DOD debate man-in-space role

THE DRIVE for a bigger military space budget—expected to surpass that of the National Aeronautics and Space Administration within the decade—is under way.

More than $1.4 billion in government research and development money will be poured into work on military space systems in the coming fiscal year. Already, this approaches half of the NASA space budget. Military astronautics makes up the largest single increase in the Fiscal 1963 Department of Defense budget, rising some $300 million above Fiscal 1962 and $600 million above Fiscal 1961.

The increase is stemming from a jump in spending on such projects as *Discoverer, Dyna-Soar, Satellite Inspector,* SPADATS, *Samos* and *Midas* reconnaissance satellites, the *Titan III* space booster, and *Advent* and *Transit* communication and navigation satellites.

Most of the spending today is going into unmanned systems for reconnaissance, communications and navigation. With the Air Force driving for a bigger role in space, funding for manned spacecraft development and for defensive and offensive weapon systems can be expected to increase, despite some Department of Defense opposition.

• **AF dominant**—Well over 90% of military space funding today goes to the Air Force. Only major exceptions are some $75-100 million going into the Army's *Advent* program and $50 million for the Navy's *Transit* and other programs.

This Air Force dominance will continue. Under the March 6, 1961, directive of Secretary of Defense Robert McNamara, the Air Force has been assigned responsibility for all DOD space programs, with exceptions only in "unusual circumstances."

The decision to give the Air Force a larger role in the NASA manned lunar program also will have a significant effect on the role played in space by the military, (see p. 52). Long-term effect of this marriage will be increased spending with industry by the Air Force —as military requirements develop from the *Apollo* project and as NASA and Air Force objectives blend.

There is, to date, little in the Air Force budget for manned space flight. But AF planning projected across the decade calls for significant and large-scale increases in this area.

Air Force leaders, faced with a growing Soviet military space threat, are carrying their fight for a bigger manned space program to Congress in an effort to overcome DOD opposition (M/R, Mar. 5, p. 12).

DOD's position, as stated by Assistant Defense Secretary John Rubel, is clear: "We cannot visualize or define now a military mission for a man-in-space."

• **Rebuttal** — Strong exception to this stand has been taken by a number of Air Force leaders:

—Air Force Systems Commander Gen. Bernard Schriever: "The ICBM, which is still in its infancy, is the first space weapon. It will inevitably be followed—more quickly than some people realize—by new space weapons that are more sophisticated and potentially more powerful. For this reason, the aerospace force of tomorrow must be able to operate in space and to detect and counter any threat in that arena."

—Strategic Air Command Director of Plans Maj. Gen. Hewett T. Wheless: "As air supremacy means control of the battleground today, space may eventually equate to control of the world . . . this may require manned spacecraft which would orbit the earth in a continuous air alert."

—Director of Advanced Technology, DCS/Research and Technology, Maj. Gen. Marvin C. Demler: "Many people believe that future aerospace forces will be primarily unmanned missiles and satellites. Yet, if we study war we find that it always has required that man's unique capabilities of reason, judgment, flexibility and adaptability be used to the utmost. We feel strongly that when the battlefield expands to include space, our posture will include those craft operating both in the aerodynamic and space environment. This force will be a mixture of unmanned and manned vehicles."

• **Implications**—What are the significant trends for industry which will emerge from this thinking? First and foremost is the expected emergence of military space as a major market.

Spending on military space systems could total some $30 billion over this decade, a somewhat surprising figure until it is realized that many military space programs now in the planning stage are highly classified. DOD total space expenditures are expected to pass total aircraft expenditures in Fiscal '67-68 and to pass total missile expenditures in Fiscal '68-69. These are unofficial but conservative industry estimates based on present military planning.

This would put spending on military space systems at a level above $6-billion in 1970, or some 80% of the combined aircraft/missile market. Of this, the military might be spending close to $5 billion with industry, compared to an equal or smaller amount by NASA.

One of the most important developments: the merging of Air Force and NASA efforts. As the Air Force attains a stronger position in the NASA lunar program, military and civilian projects will be less sharply differentiated. New Air Force programs may actually emerge from the NASA effort.

This trend already is evident in Air Force-NASA cooperation on rendezvous techniques which are applicable in the manned civilian *Gemini* program and the as-yet-unmanned military *Satellite Inspector* program.

One result of this blending of Air Force and NASA facilities, technology

and funding could be a similar consolidation of such manned programs as *Apollo, Manned Test Space Station, Dyna-Soar I* and *II, Aerospace Plane (ASP), Global Surveillance System* and *Saint II* programs. A sharp difference exists, however, in the requirements for civilian space exploration and for military space defense and offense.

Many military leaders believe the present space program is misdirected in expecting military fallout from a civilian program. They believe the emphasis should be on military space systems with the civilian scientific benefits to follow. There is not inconsiderable support in Congress for this view. It could affect the trend of space spending in the years ahead.

One Air Force officer says bluntly: "There is plenty of money in the space program. But the wrong agency has it."

DEPARTMENT OF DEFENSE

DOD is budgeting Project *Defender*, aimed at establishing the basis for a future defense system against ICBM's, at some $110 million in Fiscal '63. This Advanced Research Project Agency (ARPA) program thus will continue at the FY '62 level.

But major emphasis in *Defender* in the coming year will be placed on development of a weapon systems concept. The project thus is moving closer to a potential as an industry market.

Project *Vela*, with its *Vela Hotel* satellite system for space-based detection of nuclear explosions, is funded at $63 million in the FY '63 budget compared to $60 million in FY '62. The program is expanding with its move into the launch phase this year.

DOD is requesting, in the three service budgets, a total of $445 million in FY '63 for the Atlantic, Pacific and White Sands ranges—which support the national space programs—almost 50% more than 1962. Principal increase is for the Atlantic Missile Range, primarily for increased ground instrumentation and instrumented ships.

AIR FORCE

Air Force space budget for fiscal '63 is set at $1.206 billion, an increase of $226 million over the Fiscal '62 budget but some $250 million less than requested by the Air Force.

Major portions of the FY '63 budget break down this way (FY '62 figures in parentheses): Military space systems, $930 million ($774 million); applied space research, $102 million ($113 million); advanced technology space research, $39 million ($25 million); military construction for space, $65 million ($28.5 million); space operations and maintenance, $28 million ($8 million); space production funding, $9 million ($9.2 million).

Air Force plans to contract out 90.8% of its budget. Only $110.4 million will be spent in-house, according to the Air Force, with the remainder going to industry.

Spending by program remains classified but some project funding has been disclosed: *Dyna-Soar* will show a slight increase to $115 million. It was funded at $100 million in FY '62, with the additional $85.8 million authorized by Congress to be carried over for application to the 1963 figure. The *Titan III* space booster building block program will get under way at a level of some $50 million, with part of the total solids expenditure of $80-100 million going to development of solid engines larger than the 120-in. motors for *Titan III*.

• **Boost from Titan** — Successful initial launch on March 16 of *Titan II*, basic unit of the building block, was a shot in the arm for the entire space booster program. *Titan III* funding is expected to total some $500 million over the decade.

The program for development of a large solid rocket as a backup for NASA's initial lunar landing has been dropped, however. This program would have cost between $500 and $600 million, according to Defense Secretary McNamara (M/R, March 19, p. 13).

Emphasis will be on slower and less costly development of advanced technology for big solid boosters.

Funding of *Aerospace Plane* is being stepped up in FY '62 funds to some $19 million. The Air Force reprogramed some $9 million of its FY '62 funds for this purpose, indicating a more promising future for *ASP*. A high Air Force officer says more applied research is essential before any of the *ASP* proposals can even be talked of as a system.

Unofficial industry estimates place FY '63 spending for other programs at these approximate levels: *Samos*, $250 million; *Midas*, $200 million; *Discoverer*, $85 million; *Satellite Inspector*, $80 million; *SPADATS*, $60 million; *Global Surveillance System*, $35 million; *Military Test Space Station*, $6 million; *Orbital Weapons System*, $1.5 million.

Maj. Gen. Demler, AF Director of Advanced Technology, said on March 15 that advanced studies now under way on an orbital weapons system indicated such a project is feasible. The Air Force hopes to push this program to the advanced development stage—but is likely to run into DOD opposition. Political implications also might weigh against it.

• **$30 billion?**—What is expected to happen to Air Force spending on space for the remainder of the decade? Industry estimates predict total Air Force spending of nearly $30 billion on space systems in the 1960-70 time period. Some 55% of this, or $16.5 billion, is expected to go into strategic systems such as *Samos, Satellite Inspector, Slomar, MTSS, Global Surveillance System*, and orbital weapon systems.

Approximately $10 billion of the overall Air Force budget is expected to go into intelligence systems; $9 billion to defensive systems. Some overlap in these categories occurs in the case of programs such as *Samos* and *Midas*.

Some merging of programs can be expected as the decade progresses. The manned *Saint II* and *BAMBI* programs, for example, could evolve into a manned satellite system which would possess a reconnaissance strike capability against both ICBM's and hostile satellites. *Saint II, Slomar, Dyna-Soar II, MTSS* and *Apollo* have some common objectives which might result in a blending of the programs.

Expenditure on booster technology and propulsion for the decade is expected to total $2.8 billion. The Space Launching System, formerly the Phoenix program, probably will accelerate despite the slow start dictated by recent decisions. Use of a solid first stage in the *Nova* booster for a lunar mission still has not been ruled out, and this would be an Air Force program.

Military Test Space Station has been given a high priority as an Air Force objective. One estimate is that spending on this program could reach as much as $150 million as early as 1967 and continue to a $225 million peak within two years.

"Many of the programs that we have

Breakdown of Air Force Space Budget
(thousands of dollars)

	FISCAL '62	FISCAL '63
Major Space Systems RDT & E	$774,000	$930,000
Preliminary Research for Space		
Applied Research	$113,000	$102,000
Advanced Technology Research	$25,000	$39,000
Military Construction for Space	$28.500	$65,000
Operations and Maintenance for Space	$22,000	$28,000
Industrial Facilities for Space	$8,000	$28,000
Production Funds	$9,200	$9,000

Approved Navy Research and Development budget for astronautics and aviation medicine *(thousands of dollars)*

	FY '60	FY '61	FY '62
Bioastronautics and aviation medicine:			
Aviation medicine	449	523	620
Bioastronautics	211	315	200
Space environmental studies	0	0	850
TOTAL	660	838	1,670
Other astronautics:			
TRANSIT satellite navigation system	6,600	21,600	17,000
SPASUR space surveillance system	0	4,060	0
Space telecommunications	910	2,150	4,230
Geodetic satellite (ANNA)	0	5,400	550
GREB	0	3,025	0
Other	0	772	170
TOTAL	7,510	37,007	21,950
TOTAL	**8,170**	**37,845**	**23,620**

under way now will soon require testing of system and subsystems in the true space environment," says Lt. Gen. James Ferguson, USAF Deputy Chief of Staff for Research and Technology. "We have studied these testing requirements, and we have concluded that a manned military test station in space provides the only reasonable solution to the problems of testing equipment designed for use in space. We are convinced that a manned, military test space station program should be undertaken as early as possible."

The highly-classified *Global Surveillance System* might require total funding of some $2.8 billion by the end of FY '70. The *Global Surveillance System* is expected to be an outgrowth of technologies developed in the *ASP* and *Dyna-Soar* programs. As spending on the system increases, *Samos* expenditures can be expected to taper off. Again, some merging of these programs with *Saint II, BAMBI, Apollo* and others can be expected.

• **"We can't wait . . ."**—What happens in these programs could depend on what is learned from *MTSS*.

"We've never had a man up there taking his time looking around," says one official. "I want him to watch an *Atlas* being fired, watch the Cape. I want him to see what a nose cone looks like. They may have a fantastic signature. Once we had that, we'd have 90% capability to destroy a warhead. We can't wait for the scientist. We can't wait for the chance discovery of something we need in the military. The scientist in the satellite won't be watching the Cape. He'll be looking up. What you find depends on what you're looking for."

Air Force leaders would like to see their space programs funded directly. But if necessary, the Air Force will ride into space on NASA's coattails. Once there, it will develop programs of its own as military requirements become clearer.

ARMY

THE ARMY'S major and most affluent venture thus far into military space systems is Project *Advent*, an extended R&D program to determine the feasibility of active-repeater satellites for strategic military communications.

The project, now nearing the flight-test phase, is a three-service Department of Defense effort conducted by the U.S. Army *Advent* Management Agency.

• **Fiscal picture**—DOD has spent roughly $100 million on *Advent* to date (not including the FY '63 figures). An exact figure is difficult to produce, since the project accrued some costs of earlier communications experiments. Of the total spending on the program, an estimated 95% has gone out to industry. This percentage is likely to remain the same.

The Fiscal 1963 outlook for *Advent* is not expected to change dramatically over the $72 million allocated this year. A request for a modest increase over FY '62 funds has been made, with the final figure apt to fall between $72-100 million.

Spending to date on *Advent* has been roughly divided between construction of ground support activities and the design and development of actual flight hardware. A shift in emphasis will be noticeable in FY '63.

The installation of ground communication facilities at Ft. Dix and Camp Roberts was completed out of FY '62 funds, as was the bulk of spending required for the shipboard installation. The new budget will allocate about 80-90% of the total to actual fabrication and procurement of flight hardware and booster vehicles. Because of this shift, the major *Advent* procurements for this coming year will come through the Air Force's SSD.

• **No new contracts**—The Army anticipates virtually no new contracts for *Advent* out of FY '63 funds, except to firms already involved with the program. This policy should remain intact until at least the first round of flight tests are evaluated.

FY '63 and '64 should represent peak years for *Advent* spending, with both budgets likely to hover about $100-million per year. R&D spending beyond this point should naturally taper off as flight objectives are met.

Though extremely optimistic about the success of *Advent*, Army officials feel it inappropriate to predict the outcome of the overall program in terms of production and management of an operational system beyond the scope of the current project. Best guess is that those already in on *Advent*, including industry and the USAAMA, will remain in the key roles despite some dissatisfaction—particularly on the part of the Air Force—with the way the program is being handled.

NAVY

The Navy's space program, funded at a $24-million level for R&D in Fiscal 1962, is expected to jump to well over $50 million in FY '63.

The Navy's only major space program is *Transit*. The service sees requirements for other space systems to support fleet operations, however.

Studies made by the service over the past few years have pointed up ten space endeavors that the Navy feels "will provide direct and significant improvements to the nation's seapower":

—A space surveillance system such as *Spasur*—an electronic fence known as the "Naval space surveillance facility" before it was turned over to NORAD in November, 1960, where it has become part of SPADATS (space detection and tracking system).

—A tactical booster for naval operations and suitable for sea launch, such as the one used in the *Pogo-Hi* program.

—A satellite defense system.

—A navigational satellite, *Transit*.

—A geodetic satellite, *Anna*.

—A meteorological satellite, such as *Tiros*.

—Several communications satellites, similar to the Army's *Advent*.

—A global ground environment for space operations.

—Research that looks toward the day when manned space operations become vital to the nation's defense.

—Space-related research that may provide early warning and protection against submarine-launched ballistic missiles.

The total annual cost to the Navy of these efforts is not expected to go beyond $100 million by 1970, if the efforts even reach this figure. ❖

Host of Craft in Orbit or Near Launch

Next step may be to develop antisatellite weapons; orbital bombers loom beyond; a review of all military programs

CURRENT AIR FORCE efforts to obtain backing for manned military spacecraft are overshadowing to some extent an already formidable array of unmanned spacecraft which the military has placed in orbit or is planning to launch in the near future.

Emphasis in the programs to date has been on reconnaissance, communications and navigation. Development of spacecraft thus is following the same pattern as that of aircraft—which were first used for intelligence-gathering activities before they progressed to air-to-air combat and bombing missions.

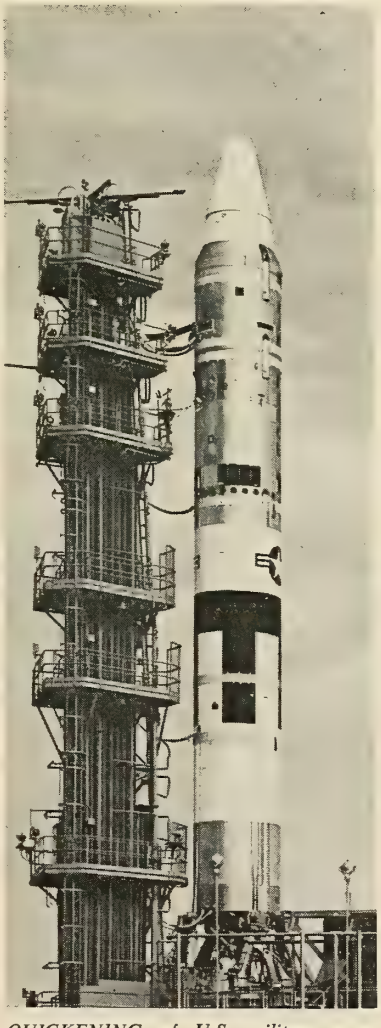
The next step is imminent. One Air Force office already has proposed an effort to shoot down a U.S. satellite. The Russians are believed to be working in this field and there is a strong feeling that the U.S. should establish an immediate capability.

Beyond this are studies under way on defensive spacecraft which could knock down an enemy ICBM or satellite, and on orbital bombing craft.

The growth of the Air Force spacecraft program has been described this way by Lt. Gen. James Ferguson, Deputy Chief of Staff for Research and Technology:

"In extending and exploiting space flight technology, the Air Force will be continuing the pattern of development which has led in a single life-span from Kitty Hawk to Cape Canaveral; from the Wright Brothers' first primitive airplane not only to Mach 3 aircraft but also through the first air-breathing cruise missiles to the *Minuteman* intercontinental ballistic missile.

"This logical progression has already led to unmanned satellites which are now essential for certain military missions. It has led from the *X-1* experimental rocket aircraft through the *X-15* and is leading now to the *Dyna-Soar*. It will lead beyond, to manned space stations and possibly to advanced aerospace craft capable of self-contained flight to and from space. All of these advanced craft have potential applications to critical military missions."



QUICKENING of U.S. military space drive is symbolized by AF Martin Titan II shown before successful first launch March 16.

Military planners do not believe spacecraft developed solely for the scientific missions of the National Aeronautics and Space Administration will serve military needs.

"*Mercury* is good enough for the scientists," says one, "but I want to land at a pre-selected site and do it over and over again. The ballistic reentry is like flying a Boeing 707 to New York and then dumping it in the ocean."

Military spacecraft programs, while largely concentrated in the Air Force, are spread throughout DOD and the three services.

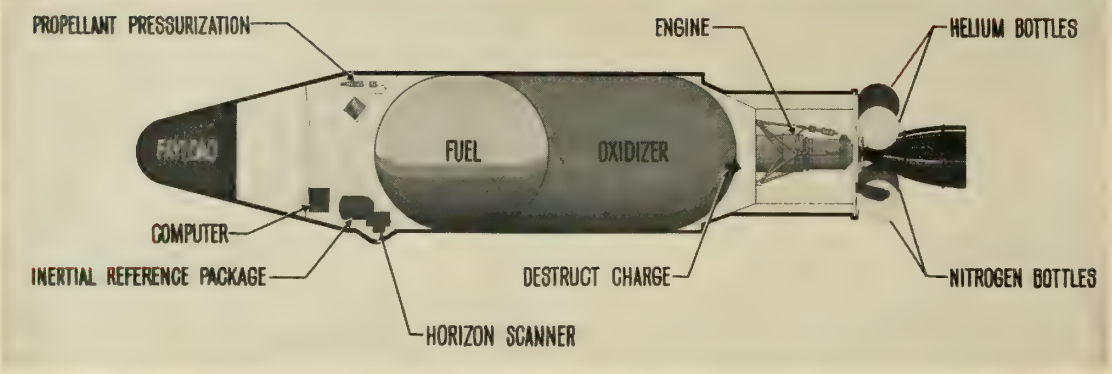
DEPARTMENT OF DEFENSE

• **BAMBI.** Advanced Research Projects Agency is studying proposals for a satellite system which would employ space-based platforms and interceptors for destruction of enemy ICBM's during the boost phase. This is being carried on under the $110 million alloted to Project *Defender* in Fiscal '63.

ARPA, however, is leaning at the moment more toward the ground-based terminal defense concept of *ARPAT*, a possible alternative to *Nike-Zeus* now being studied by the Army Ordnance Missile Command and Raytheon Co., prime system contractor.

"Conceptually, on first look, *BAMBI* looks like a very attractive scheme," says one ARPA scientist, "but the more you study it the less appealing it becomes."

Present objections to the satellite system seem to be its extremely high cost and the technical problems involved in an orbital weapons system. While it



BASIC AGENA vehicle has been highly successful in Discoverer and other programs. Cutaway shows Agena B version of Lockheed series. The new Agena D will be tested in the Discoverer program, test bed for Samos and Midas.

still is too early to put a price tag on the system, ARPA scientists point out that "we're talking of considerably more than 10 satellites and a cost of more than $1 billion."

• **ARENTS.** General Dynamics/Astronautics is prime on this program of three payloads for space environmental testing. Satellites are to be boosted into 22,000-mi. orbits by the *Atlas-Centaur* booster. Delay in *Centaur* means this project has slipped into early '63. ARPA is carrying the program out in conjunction with NASA, with the payloads to be carried aloft in NASA satellites.

• **Vela Hotel.** ARPA, working with AEC and AFSC, is developing a six-satellite operational system for detection of nuclear explosions in outer space as part of the overall Project *Vela*. Los Alamos Scientific Laboratory is developing the payload. Booster will be the *Atlas D-Agena B* combination, with two *Vela Hotel* payloads to be mounted in opposition so that solar flares will not trigger the alarm system (M/R, Oct. 23, 1961, p. 12).

AIR FORCE

The Air Force today is emphasizing the growing need for manned military spaceflight while continuing development of a number of unmanned systems. The latter are designed to fulfill missions where man is not required, and to provide the advanced technology for manned systems which will follow.

Manned Spacecraft

Current and proposed USAF manned spacecraft of the time period between now and 1970 span a range from rocket craft to air-breathing nuclear-powered space planes and orbiting space stations. They include:

• **X-15.** North American Aviation's successful development of the three *X-15* rocket research aircraft powered by Thiokol XLR-99 engines developing more than 50,000 lbs. thrust has contributed to knowledge of heating and re-entry problems, as well as probing the bioastronautic effects along the lower edges of space. This is a joint Air Force-Navy-NASA program which has achieved speeds in excess of 4000 mph and altitudes of 217,000 ft.

• **RS-70.** The on-again off-again RS/B-70 program contains within it a study plan of the RS-70 as a recoverable first-stage booster. This calls for development of a non-recoverable intermediate stage booster rocket with a thrust of some 300,000 lbs. The recoverable booster system (RBS) would be capable of launching a craft such as *Dyna-Soar* into orbit. The plan can be generously described as dormant.

• **Dyna-Soar I.** Re-orientation of the *Dyna-Soar* program for development of a manned boost-glide orbital spacecraft has eliminated plans for sub-orbital flight. The program will proceed directly to orbital flight, with use of the Martin *Titan III* as a booster.

Despite Air Force efforts to push *Dyna-Soar I* as the forerunner of manned spacecraft, DOD is holding the project to a research program of the *X-15* type. Launch will be from Cape Canaveral; recovery at Edwards AFB. Boeing Co. is developing the spacecraft and serving as systems integrator. *Dyna-Soar* is important as a test bed for winged re-entry.

• **Dyna-Soar II.** Plans for an advanced *Dyna-Soar II* with on-board propulsion call for a manned craft which could be capable of performing the rendezvous mission. *Dyna-Soar II* also might be given the manned *Saint II* mission. It would provide a basic craft for orbital reconnaissance, defense and offense which could be phased into the Global Surveillance System.

• **Aerospace Plane (ASP).** This is an advanced research program aimed at development of a vehicle capable of taking off conventionally from current runways, climbing through the earth's atmosphere to perform its mission, and returning to its home base. The Air Force is giving the concept serious consideration. Program is not yet oriented toward any given system or vehicle.

Six separate study programs are involved—at North American, Boeing, Douglas, General Dynamics, Lockheed and Republic. The program today, as funded in the FY '62 and FY '63 budgets, is principally concerned with investigation of promising new methods of aerospace propulsion and with structural design. Propulsion concepts include the Marquardt-developed LACE (liquid air collection engine) and NULACE (nuclear LACE).

ASP could be developed as a follow-on *SLOMAR* vehicle, and also could provide the basic airframe for the Global Surveillance System. Outcome of *Dyna-Soar II* planning could affect the *ASP* program.

• **Military Test Space Station.** The Air Force is pressing for early development of MTSS. It would provide a space station for testing of components and subsystems in the space environment, bioastronautics exploration, and development of techniques for space navigation, rendezvous and interception. It also could provide the basic system for a manned satellite command post.

The Air Force concept calls for a 12-man crew module, with provision for attachment of control and test modules. Crew could be ferried to and from the station in *Dyna-Soar II* or *Saint II* winged re-entry vehicles. The Air Force is now giving serious consideration to a proposal that this be a coordinated

program with NASA, perhaps using the *Gemini* vehicle as a crew ferry.

"Through this coordinated program, it seems reasonable to assume that the best interests of both the military and civilian test programs in space could be served," Gen. Ferguson says.

• **SLOMAR.** Feasibility studies have been under way for some time on the Space Logistics Maintenance and Rescue system. One industry forecast predicts *SLOMAR* might develop into a $3.7-billion-dollar system between now and FY '70. The *SLOMAR* vehicle, possibly based on a Recoverable Booster System, is designed to carry five or more passengers.

Industry studies such as Martin-Denver's Project *Deimos* are exploring this concept (M/R, Aug. 28, 1961, p. 16). Lockheed Aircraft Corp. is the other firm holding a study contract in this area. *ASP* could develop as a follow-on *SLOMAR* vehicle, but is not likely to be the initial vehicle since *SLOMAR* requirements are expected to precede *ASP* development. Programing of *MTSS, Dyna-Soar II, Saint II* and *Gemini* can affect *SLOMAR*'s future.

Aeronautical Systems Division and Space Systems Division both are involved in these studies, with the SSD in-house feasibility study being carried out as SMART (Space Maintenance and Repair Techniques).

• **Saint II.** This is the manned follow-on vehicle of the unmanned *Satellite Inspection* program, still known as *Saint* despite efforts to change the name. It would be a winged re-entry vehicle, which means its *Satellite Interception* mission could be assigned to *Dyna-Soar II*. Air Force-NASA cooperation on the rendezvous mission will affect this project.

• **Global Surveillance System.** *ASP* and *Dyna-Soar II* both are expected to contribute to the technology of the Global Surveillance System, a highly-classified study program for a manned reconnaissance-strike space vehicle. The system could enter the development phase within the next fiscal year for start of production in the FY 1966/67 budgets. Operational date then would be 1970. Company research studies already are under way on development of the navigation system and other subsystems.

• **Orbital Weapons System.** Studies now are being conducted on two classified weapon satellite projects to determine the feasibility of an orbital bombing system. The Air Force considers these studies promising, and hopes to push the program into an advanced development stage. This later could develop as an outgrowth of the *Saint* and *BAMBI* programs, effective against both missiles and satellites.

"As far as the Air Force Space Plan is concerned, it will be one of our major interests down the road," says Maj. Gen. Marvin C. Demler, USAF Director of Advanced Technology.

Unmanned Spacecraft

Current USAF unmanned spacecraft are designed principally for intelligence-gathering missions. The Air Force would like to have a communications satellite program of its own—due to a belief that the *Advent* program is inadequate to meet AF requirements for command and control in space. This would be a low-altitude active repeater system. Top Air Force officials feel the present program, snarled in service politics, has been poorly handled by DOD. Unmanned USAF spacecraft include:

• **Discoverer.** The "open-end" *Discoverer* program, managed by Lockheed Missile and Space Co. for Space Systems Division, has been the nation's most successful military satellite program. Number of launches now is nearing 40. Eleven capsules have been recovered from orbit to date, seven of them in air-snatches by C-119 and C-130 aircraft.

Discoverer, boosted by *Thor-Agena* and *Atlas-Agena* combinations, has served as a test bed for the *Midas* and *Samos* systems. The *Samos* reconnaissance satellite has a similar requirement for returnable capsules. *Discoverer* is serving as a "platform program" for advancing a number of hardware techniques. Development of the Bell-engined *Agena* upper stage in the program has made available one of the most successful military upper stages, capable of on-orbit stabilization and re-start. The new *Agena D* will be tested in this program. The re-entry vehicle is being developed by General Electric.

• **Midas.** This early-warning satellite for infrared detection of ICBM launches is nearing the operational stage, set for mid-1962. The system may consist of as many as 12-15 satellites in polar orbit. The *Midas* test satellite is reported to have proved its capability in early detection of a *Titan* launch from Cape Canaveral. The system employs an *Atlas* booster. The infrared detector system is supplied by Aerojet-General.

• **Samos.** The reconnaissance satellite program now is being carried on behind a tight security curtain which has eliminated even references to the name from AF unclassified documents. *Atlas*-boosted, the *Agena* satellite carries high-resolution cameras with provision for ground relay of photographs. Recoverable film capsules also are contained. Initial results from first R&D launchings have been highly promising. The system is scheduled to be operational in late 1962. Major factor in increasing operational life to as much as a year has been used of solar power cells (M/R, July 24, 1961, p. 14).

• **Saint I.** Now known officially as *Satellite Inspector,* Program 621A is expected to provide early demonstration of military rendezvous techniques and prove out rendezvous and docking technology. Initial launches of the RCA-designed spacecraft are scheduled soon from Cape Canaveral with the *Atlas D-Agena B* combination as a booster. Target satellites are to be launched by *Blue Scout*. The *Saint* vehicle will employ retrorockets for rendezvous after being placed into orbit ahead of the target satellite. Television cameras will be used for identification of target.

The program is expected to lead to a manned winged re-entry vehicle for interception of hostile satellites and crew ferry missions, a project known informally as *Saint II* and formally as *Satellite Interceptor.*

ARMY

Before the end of the year, Army officials hope to have the 1250 lb. *Advent* spacecraft in a 5000-mi., five-hour, inclined orbit. Design of the first experimental version of the satellite now is complete.

Two more launchings of this type aboard *Atlas-Agena B* boosters tentatively are planned to follow at 3-4-mo. intervals.

A later series of tests, scheduled to begin sometime in 1963, will place advanced versions of *Advent* satellites (based on system improvements made as a result of the first series of launchings) in synchronous 24-hour equatorial orbits 22,300 miles above the earth. At this altitude, the satellite's orbital speed is proportionally the same as the earth's rotational speed, making the satellite appear to be stationary in outer space.

This type of orbit, of course, removes restrictions imposed by early communications satellites when message transmission or rebroadcast could be accomplished only during the few minutes when the satellite was passing through the line-of-sight (LOS) range of the ground station.

Ultimately, the Army will attempt to place a series of operational prototypes (a minimum of three) in synchronous equatorial orbits around the earth spaced about 120° apart, which will provide a virtually complete and instantaneous microwave communications link for facilities anywhere on the globe.

• **Centaur lag crucial**—In order to place both advanced experimental versions and operational prototypes in the

22,300-mile orbit, the Army is planning on using the *Centaur* upper stage with the *Atlas* boost vehicle. However, this program has slipped badly (M/R, Feb. 12, p. 13), and there is considerable concern over meeting the advanced flight phase schedule.

• **Other interests**—Though *Advent* is by far the biggest and most expensive Army space project, the service is pursuing some other programs—and is keeping an eye on still more possibilities for the future.

Included in Army plans are:

SECOR (Sequential Collation of Range)—This Corps of Engineers program is actually a relatively simple and lightweight (36 lbs.) satellite-borne ranging device, to be used primarily for geodetic purposes. The system employs a series of three ground stations—each positioned in a well defined terrestrial location—to determine the exact spacial coordinates of the *SECOR* satellite. A fourth ground station is set up at the point to be surveyed and a highly accurate fix of the location is determined by measuring its range to the satellite at several accurately measured points in the vehicle's orbit.

SECOR can operate either as an independent satellite or as a transponder package carried aboard satellites of other programs. The latter method has been employed with two Navy *Transit* launches and one AF *Discoverer* launch to date. The first attempt to launch *SECOR* as an independent vehicle was made in January aboard the five-in-one *Composite I* package which was aborted due to a booster misfire.

The Army hopes to place another independent version of *SECOR* in orbit piggy-back fashion later this year.

Though some operational data have been achieved with earlier launches aboard *Transit* vehicles, the Army has not been able to fully test the system due to less-than-perfect orbital paths.

Prime contractor for *SECOR* is the Cubic Corp. of San Diego, which turns out the satellites at a cost of roughly $500,000 each. The initial four ground stations, now completed, ran into considerably more expense.

New ComSat?—There is some feeling within Army technical circles that the pressing need for military communications via satellite may give rise to a system to handle emergency communications which could go into operation before the synchronous-altitude net of *Advent*.

The issue is not at all clear at this point, since it has not been determined exactly what role the low-altitude *Advent* shots slated to be orbited this year could play in such a mission. Certainly no new system could be operational before then.

The argument for maintaining at least some operational capability for military space communications evolved when Army's *Courier* program was cut short in late 1960, after *Courier-1B* had successfully demonstrated its delayed active-repeater capability.

Lunar Construction — The Army, with NASA encouragement, has already made what is described as "a modest investment" in design studies for a large lunar environmental chamber where the Corps of Engineers could go about developing construction techniques which would be needed to support any large-scale manned exploration of the moon.

Congressional appropriation of funds for an environmental chamber for this mission may be forthcoming within the next 12 to 18 months.

Lunar Mapping—The Army is also reportedly considering development and installation of a lunar-mapping package to go aboard a moon orbit or impact vehicle in order to update a current Corps of Engineers lunar mapping program.

Meteorological Satellite Needs—With no formal program of its own in this area—but as a vital customer for accurate weather data — the Army maintains close ties with NASA and the U.S. Weather Bureau on development of meteorological satellites, in an effort to feed in as many requirements as possible. The basic Army need in this area, in addition to accurate overall forecast information, is real-time readout of cloud cover in remote local area.

NAVY

The Navy, taking a conservative approach to space, has chosen to study systems well within the state of the art. *Transit*, the navigation satellite system, currently is the Navy's only major space project. However, a geodetic satellite—the classified project *ANNA*—is being funded and may become a major program within the next several years.

The Navy also is cooperating with other agencies on space work, with NASA on the *Tiros* weather satellite program and with the Army on *Advent*.

• **Transit**—The Navy's *Transit* program is aimed at establishment of a highly accurate, all-weather aerial and maritime navigational system. All four satellites of the operational system are scheduled for launch by late this year.

Transit IV-B was successfully launched November 15, 1961, into a near-circular orbit of 650 miles. It carried with it, pickaback, also to a successful launch, a *Traac (Transit* research and attitude control) satellite.

Orbiting of *Transit IV-B* marked the fifth successful *Transit* launch and the second space vehicle to carry a nuclear power-supply—*SNAP* radioisotope units for powering two of the satellite's four transmitters.

Three of the Navy's earlier *Transit* satellites still in orbit have provided geodetic data which have led to improved knowledge of the earth's shape and gravitational field. In addition, navigational experiments were successfully conducted using a moving experimental range ship and *Transits II-A and IV-A*. (*II-A* was launched June 22, 1960, and *IV-A* on June 29, 1961).

Transit IV-A was the first triple payload ever successfully ejected into orbit. Pickabacking were *Injun* and *Greb III* which separated from *IV-A* but not from each other. *Injun* and *Greb* were sent up to determine characteristics of space radiations, and *IV-A* to check out a magnetic stabilization system and the first nuclear power-supply in space.

The Navy's Bureau of Naval Weapons holds overall management responsibility for *Transit;* and the Applied Physics Laboratory of The Johns Hopkins University holds the prime contract and also is responsible for developing the satellite payloads.

Transit IV-B is structurally and functionally similar to the *IV-A*. It weighs about 200 lbs., is in the form of a drum-shaped shell 43 in. in diameter and 31 in. high, and is covered with solar cells.

The *Transit* navigational system is based on the Doppler shift phenomena. Signals picked up by a ground station show changes in the signals from the stable oscillators in a satellite as the vehicle first approaches and then passes over the ground station. The position and velocity of the satellite at some specified time can be calculated by measuring this shift.

With this Doppler information and other force terms affecting the satellite's motion, future orbits can be predicted several days in advance. This information, provided by means of the satellites's own signals, will yield an operational navigational system usable by ships and aircraft under any weather conditions.

Operational *Transit* satellites will be completely transistorized, will weigh about 100 lbs. each, and will have an expected operational life of five years.

Traac is a doorknob-shaped satellite weighing about 200 lbs. It was designed to check the possibility of orienting a satellite by means of gravity so that the vehicle always has the same face pointing at earth, as does the moon. It also was to get data on the characteristics of the particles in the earth's radiation belts. Test results from the pickaback launching of Nov. 15, which includes *Traac*, have not yet been released by the Navy. ⌗

Trend Toward More Incentive Awards

Air Force also plans to facilitate contract management by delegating more authority, adopting mechanical source selection

THE MILITARY SPACE program will be marked for greater use of incentive awards to industry and streamlined contract management by the Air Force.

The system will feature more delegation of authority to lower management levels. Joining it in the list of innovations will be a mechanical source selection system and the probability that more use will be made of "associate" contractors.

The AFSC setup is especially important because it awards by far the largest share of the Defense Department's Fiscal 1963 military space budget of $1.5 billion.

Robert E. Miedel, of the AFSC's office of assistant for management policy, declares, "Incentive contracts are here to stay."

He said that while the trend is fairly new, the biggest share of the Air Force contracting dollar is now awarded through incentive contracts.

"Next year, both the Air Force and industry will have greater experience in its negotiation. This will encourage further use," he continued.

• **"Management by exception"** — Currently, the Air Force is authorized to pay a 10% fee for superior performance for production contracts and 15% for R&D contracts. Notwithstanding the statutory limitation, the Air Force requires Secretarial approval for fees in excess of 7% for production contracts and 10% for research and development contracts.

Director of the AFSC procurement setup is Brig. Gen. William E. Leonhard who serves as Deputy Chief of Staff, Procurement and Material. He heads a buying operation which has a complement of approximately 16,000.

AFSD's streamlined procurement setup will be highlighted by a philosophy of "management by exception." It features more delegated authority.

Various divisions of the command can now award contracts up to $5 million, compared to an earlier $1 million. AFSC centers can dole out to industry contracts worth up to $500,000. The

BRIG. GEN. W. E. LEONHARD
AFSC's Deputy Chief of Procurement.

streamlining is further pointed up by new procedures which will have "our pre-procurement and post-procurement people working on the same team."

In the procurement of systems, the Air Force "buyers" will now be physically located in the Office of the System Program Director. Even though he will continue to report to procurement officials, the very closeness of the physical location will make him more responsible to the systems needs, Air Force officials claim.

In the procurement operation, an administrative contracting officer (ACO) will be placed in a plant to monitor one system's contract work, rather than all the work at the plant. If several contractors are working on a major portion of the systems and when justifiable, an ACO will be placed in each of their plants.

The ACO—in turn—will be directly responsible to the systems program director. Meidel believes contracting firms will find that they have less and less cause to call or contact AFSC headquarters. Instead, the SPD will be able to solve many of the problems.

• **Overhauling** — Other major changes and thinking on procurement policy revealed by Air Force officials include:

—*Better source selection*—This is a major effort to provide better source selection and to cut down the so-called "brochuremanship" which plagues industry and military contracting officials.

Under the system, a firm fills out a standard Form 220 on which it lists information pertinent to the firm's contractural capability. This information is then placed on electric computer cards. Visual scanning is used to select the needed firms under what is called the Mechanical Source Selection System.

To get on the source selection, a firm files an AFSC Form 220 and keeps it up to date as its individual situation changes. There are currently 2600 R&D firms on the list; about 700 are being added per year.

To insure greatest objectivity in source selection, AFSC now requires that at least one other technically competent person besides the program initiator take part in the selection of the firms which will be asked to submit bids.

—*Associate contractors*—rather than a single prime—may well become more common in future Air Force contracting as the Air Force Systems Command exercises stronger technical and financial management.

AFSC believes that, of necessity, "letter contracts" will continue to be used—possibly in greater numbers. Nevertheless, it is making strong efforts to cut the time now being taken to definitize these contracts.

While AFSC does not anticipate any major changes in its procurement policies, it is studying its procedures with the aim of streamlining.

The three main types of contracts will continue to be cost-plus-fixed-fee, fixed-price and incentive.

• **The drill**—Here is the rundown on normal operating procedures when AFSC initiates a procurement with industry:

The procurement (or purchase re-

quest) emanates from the technical organization of an AFSC division or center. It includes a list of firms considered by the program initiator to be capable of doing the work. It is forwarded to the contracting officer of the respective organization.

The buyer checks the source list and may add more firms in coordination with the program initiator following a report from the mechanized source evaluation system. He then prepares a request for proposals to industry.

The replies go back to the buyer. He extracts the cost portion and begins an analysis of it. The technical information goes to a board of from several to as many as 25 technically qualified persons. This group breaks out all the factors and rates the companies as to their capability.

The technical and procurement personnel decide which firm would best perform the contract, based on cost and technical competence. Once the contract is awarded, its administration is passed on to one of the three contract regions (see p. 151). Firms who feel they have a good idea for a new space system can submit an unsolicited proposal.

An unsolicited proposal is sent to AFSC headquarters, or one of its centers or divisions. It is then sent to the organization which has technical management responsibility over the area in which the proposal is submitted. It is then reviewed and approval or disapproval given.

There are two other procedures in which a firm can get into the AFSC contracting team.

One is by getting placed on the list of firms which receive Air Force Technical Objective Releases. This document lists all technical areas in which the Air Force feels it may have future requirements.

The other is the Commerce Department's synopsis of government requests for proposals. Firms which did not receive an Air Force request for proposal can use this to keep aware of what contracts are going to be awarded. They can then request the AFSC division or center to permit them to submit a proposal.

• **Prime SSD contact** — Procurement of space vehicle systems is the responsibility of the Deputy Commander for Aerospace Systems (DCAS), located in AFSC's complex at 5800 Arbor Vitae St., Los Angeles 45, Calif. (Building 4).

Primary point of contact for both small and large industry seeking new business with AFSC's Space Systems Division therefore is not in SSD or Aerospace Corp. but in the Contractor Relations and Small Business office (DCMB) of DCAS. This is true even for the large company already doing business with SSD.

DCMB does no buying or contract management. SSD has its own buyers and contracting officers. But, for the duties it performs, DCMB is the sole office in the U.S.

It counsels potential contractors and subcontractors, both large and small, on space programs, makes preliminary evaluations of company capabilities, and adds the firms to the source file which it maintains. When an SSD procurement comes up, DCMB provides the source list.

No security clearance is needed to visit DCMB. But the office will assist in obtaining appropriate security clearance after a need to know has been established. DCMB officials ask that interested firms write or telephone (ORchard 0-1444, Ext. 1005) in advance of a visit.

Firms interested in participating in AFSC space programs can obtain the Form 220 ("Research and Development Source Information") from DCMB or any AFSC procurement office (see page 150). These forms should be sent directly to Headquarters AFSC, Andrews AFB, Washington 25, D.C. The information then is distributed to all AFSC commands, including DCMB.

DCMB arranges formal presentations of contractor capabilities to SSD.

For those unable to visit DCAS, the contractor relations and small business specialists at the nearest Contract Management Region or Air Procurement District can provide assistance.

• **Small business guardian**—Here is how the system works:

After design criteria and specifications have been established for a new space system, DCMB is asked to screen its contractor source files for the names of those contractors qualified for consideration to receive a Request for Proposal (RFP).

This list is forwarded to the Source Selection Board. Those firms which meet the requirements are invited to bid on the program. The proposals submitted by contractors in response to the RFP are evaluated by the Source Selection Board. The board recommends to the Commander, DCAS, the best qualified contractor. On exceptionally large procurement, DCAS forwards the recommendation through AFSC to the Secretary of the Air Force for final selection.

"Today, we submitted 60 names on a procurement and the Source Selection Board cut it to 30 or 40, taking those best qualified," says Joseph Krueger, DCMB assistant for procurement sources, in explaining the system. "They did this cold, not knowing whether the companies were large or small. I followed up and found there was not a small business represented. So I told them to drop down and pull up some of those small ones."

Thus the DCMB office, in addition to its other duties, acts as a watch dog for the interests of small business. Lt. Gen. Howell M. Estes, Deputy Commander for Aerospace Systems, is "pounding the desk all the time to give more help to small business," says Roy A. Watkins, chief of the DCMB office.

• **Competition swells** — This search is carried out actively. DCMB sends out thousands of letters to potential contractors reminding them to obtain and fill out a capabilities form so that they can be listed in the source file.

One result is a significant increase in competitive buying in the space program in the past year.

Some 35% of the procurement handled through Watkins' office now is going eventually to small business, either directly or as subcontracts from primes and major subcontractors. The aim today is an additional 10% increase for small business.

• **Navy contracting**—The Navy's Bureau of Weapons is also moving toward more delegated authority and incentive-type contracts.

In fact, in terms of numbers of contracts, it is far ahead of the DOD. In the first half of Fiscal 1962, total DOD awards in fixed-price incentive contracts were 12.5%. BuWeps percentage was 24½%.

At present, procurement officials report, almost all incentive contracts are in the non-space area. This, however, will change.

The Navy move to delegate authority is also centered in its factory representatives. The whole area is being studied by procurement officials, but no decision has been made as to the scope or policy changes which will be made.

The BuWeps contracting setup and procedures closely resemble AFSC operations. Firms wishing to get on BuWeps bidders list file a Standard Form 129. They should be sent to: Department of the Navy, Chief, Bureau of Naval Weapons, Code: NCS-41, Washington 25, D. C.

Procurement is initiated by the Bureau of Weapons and the Program Management Office for each system.

Proposals are evaluated by an Evaluation Board composed of technically qualified personnel and procurement officials. Primary emphasis is placed on technical competence of the firm and technical feasibility of the proposal submitted.

(For more information on Navy and Army procurement policies and procedures, see pp. 124 & 132.) ⌗

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DISPLAY SYSTEMS In just a few seconds, or even less, command control centers can observe intelligence data as it develops in far-distant areas — friendly factors and hostile factors — all in convenient, graphic form, projected on a screen 30 feet square. Much of the data received, whether in digital or analog form, is charted dynamically and can be seen instantly by those present. Such is the proven capability of Kollsman Information Display Systems, which also provide an automatically plotted record of incoming information, and provision for injecting written commands into the projected image. Reliability and easy maintainability are inherent in the systems, now available for commercial and military requirements.

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First tire ever made to withstand scorching heat

To qualify for the B-70 Mach 3 aircraft, this tire must function for prolonged periods at a *temperature of 360° Fahrenheit.* Conventional aircraft tires could not survive even one mission at such oven heat.

Thus B.F.Goodrich engineers had to achieve technical break-throughs in both materials and design for the B-70 tires. In qualification tests, the tires were exposed for several hours to a 360°F environment, and then subjected to a number of simulated flight cycles—takeoff, flight mission, and landing—at this high temperature. The BFG tires have now passed qualification tests, nearly a year ahead of schedule.

The BFG tires set a milestone in tire efficiency, yet size is reduced over conventional designs. The usual aspect ratio (height to width) is 85% to 90%. The B-70 tire ratio is 63%. While difficult to build, this means that tires occupy less precious space.

Any way you look at it, this is the most advanced tire ever built . . . and the only one qualified for the B-70. Good reason for you to depend on B.F.Goodrich tires for anything on wheels. For information write *B.F.Goodrich Aerospace and Defense Products, a division of The B.F.Goodrich Company, Department MR-3, Akron, Ohio.*

This is what happened to conventional jet tire after oven cooking.

BFG TIRES TAKE ON THE TOUGHEST JOBS

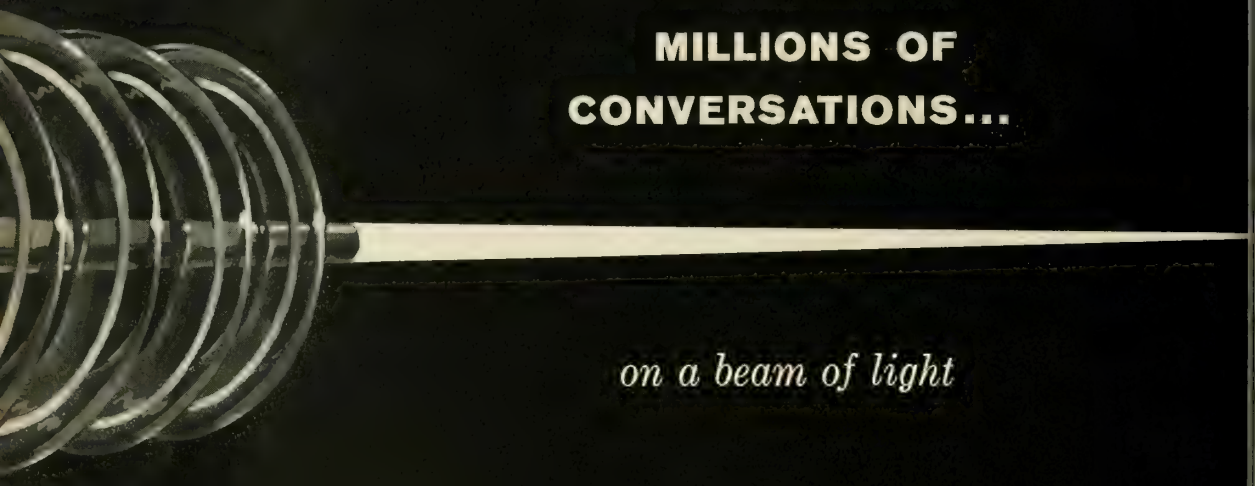
MACH 3 B-70 being built by North American Aviation . . . tires must withstand hours of elevated temperatures.

ROCKET-POWERED X-15 . . . leans back to land on special skids, then comes down on dual nose wheel tires with high impact. Only BFG fabric tread tires are used on the X-15. Nylon laminates are sandwiched right into the tread to reduce internal flexing and overheating. This type of tire construction is now used on virtually all military and commercial jets.

GENERAL DYNAMICS B-58 . . . requires a tire takeoff capability of 300 mph, faster than any other aircraft. The 16 main tires are only 22 inches in diameter, thus tires are subjected to extremely high stresses. BFG tires having a high-speed compound with BFG fabric tread design are qualified for this service.

B.F.Goodrich aerospace and defense products

SPACE COMMUNICATIONS



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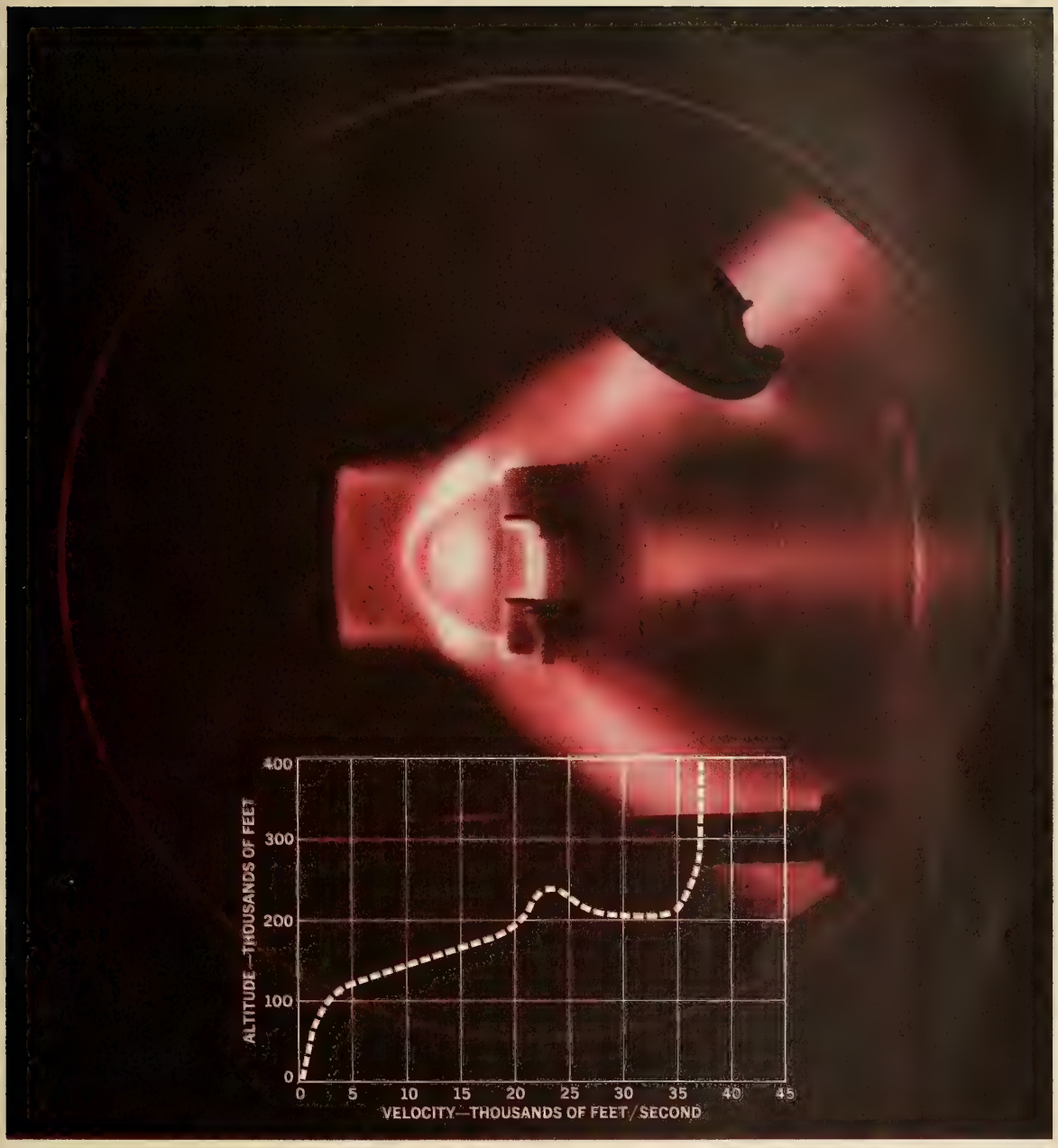

Dress rehearsal: re-entry from a space mission

Avco's new Space Sciences Laboratory integrates simulation studies of re-entry conditions associated with lunar and interplanetary missions. Facilities, including Avco's Super-Orbital Vehicle Re-entry Simulator (above), gather new data in such areas as heat transfer at supersatellite speeds, optical radiation from flow fields around vehicles, electromagnetic propagation through the plasma sheath, surface interactions between vehicle and atmospheric fringe, and high-temperature materials. Planned additions will give information on re-entry conditions in the atmospheres of Mars and Venus. Data, supported by Avco's advanced capability in systems analysis, design and development, will help provide reliable performance predictions in these critical areas.

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MILITARY SPACE
NASA/DOD

AF Support Role Grows, NASA Still In Charge

NASA'S DRYDEN

DOD'S LARSEN

AF'S McMILLAN

THE AIR FORCE expects to spend close to $400 million in support of NASA's space program in Fiscal 1963. The twelve-month effort more than doubles Fiscal 1962 expenditures of $160 million.

It also sharply accentuates the growing role of the military in America's peaceful space programs. That role will reach its high point in Projects *Gemini* and *Apollo*.

In NASA's two-man space program, the Air Force will be responsible for the procurement of both the *Titan II* and *Atlas-Agena* launch vehicles which will be used. In addition, the Air Force will provide the launch site, launch crew and tracking.

Further DOD participation will be spelled out by a joint study group now working on the problem.

For Project *Apollo*, the Air Force Systems Command is setting up a liaison office to work with D. Brainerd Holmes, director of NASA's Office of Manned Space Flight.

The office — Deputy Commander, Manned Space Flight—will be responsible at the operating and management level for Air Force participation in the lunar program. Other offices will be set up for coordination with various NASA field centers.

Maj. Gen. Osmond J. Ritland, Commander, AF Space Systems Division, reportedly will be named to head the liaison office which is already set up.

• **NASA is boss** — One thing is clear—the Air Force will have no management responsibility in the lunar program. This will continue to reside in NASA.

Its research support of the lunar program will be extensive, however. One area in which the Air Force will make a major effort is bioastronautics. Others are certain to be launch technology and operations.

The agreement on *Gemini* will be mutually beneficial. The AF has already conducted extensive research into the problems of rendezvous in space—which obviously has vast military implications.

Since the prime purpose of *Gemini* will be to prove the feasibility of rendezvous, NASA will gain from the AF experience, while the Air Force will have access to the information obtained in the program.

Another major area of support is the temporary assignment of officers of all three of the military services to NASA. Approximately 100 Air Force and about 20 Army and Navy officers are now serving with the space agency. Highest ranking is Brig. Gen. Charles Roadman, director of NASA's space medicine efforts. Others have important positions at NASA headquarters and various field centers. One Air Force officer serves as one of NASA Administrator James E. Webb's chief assistants.

• **Space ground rules**—The organizational framework for closer military cooperation with NASA in the exploration of space was established in a declaration on Feb. 24, 1962, by Secretary of Defense Robert S. McNamara.

Primary responsibility for assisting the space agency was assigned to the Air Force, but provision was made for other military services to participate if McNamara so decides.

The policy statement declares that "It is in the national interest for the Department of Defense, to the extent compatible with its primary mission, to make its resources available to NASA, in the form of facilities and organizations, in order to employ effectively the nation's total resources for the achievement of common civil and military space objectives.

"Except as the Secretary of Defense may otherwise direct, the Secretary of

DEPARTMENT OF DEFENSE DIRECTIVE

Feb. 24, 1962

SUBJECT: *Department of Defense Support of National Aeronautics and Space Administration (NASA)*

References:

(a) *DOD Directive 5160.32, "Development of Space Systems"*
(b) *DOD Instruction 5129.34, "Central Supervision of Ground Environment Equipment and Technical Facilities"*

I. PURPOSE

The purpose of this directive is to assign responsibility within the Department of Defense for effective and coordinated management of Department of Defense support to programs of the National Aeronautics and Space Administration. Responsibilities assigned by references (a) and (b) are not affected by this directive.

II. POLICY

It is in the national interest for the Department of Defense, to the extent compatible with its primary mission, to make its resources available to NASA, in the form of facilities and organizations, in order to employ effectively the nation's total resources for the achievement of common civil and military space objectives.

III. RESPONSIBILITIES

A. Basic agreements between DOD and NASA relative to program content, funding, scheduling and assignment of responsibilities for programs requiring DOD support to NASA will be made by the Secretary of Defense and the Administrator, NASA.

B. The Director of Defense Research and Engineering is responsible for the conduct of studies, program analyses and other activities necessary to the establishment of basic agreements by the NASA and DOD relative to NASA programs for which DOD support is required or contemplated. Such studies and analyses will concern feasibility, desirability, scope, and other factors with particular emphasis on determinations concerned with division of effort between NASA and DOD. In addition, the Director of Defense Research and Engineering will provide, subject to the approval of the Secretary of Defense, policy guidance to all DOD components on the scope, program content, scheduling, level of funding, and level of effort to be maintained under basic agree-

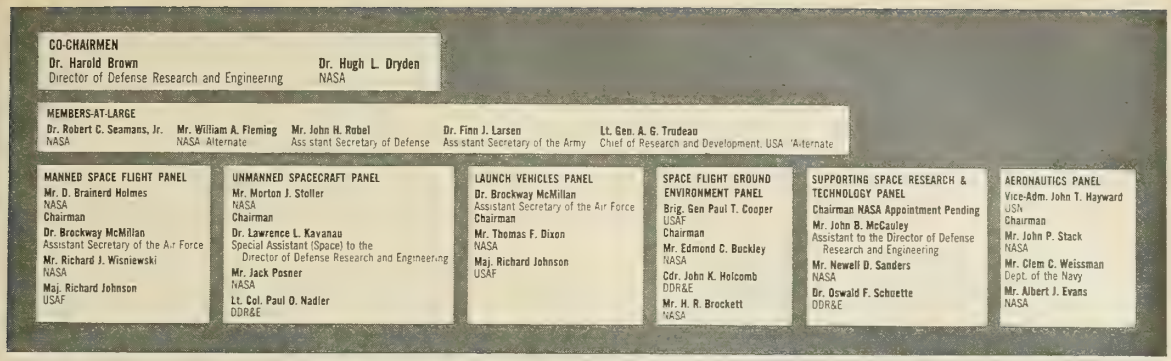

Chart Shows Civilian-Military Space Relationship

the Air Force is assigned responsibility for the research, development, test, and engineering of satellites, boosters, space probes and associated systems necessary to support specific NASA projects and programs arising under basic agreements between NASA and DOD."

The object of the declaration is to end the disunity—and sometimes conflict—that has existed between the civilian and military space programs and to establish close technical working cooperation.

• **Down to specifics** — Up to this point, the cooperation between the two programs has been almost completely at the policy-making level, with either Webb and McNamara or the Aeronautics and Astronautics Coordinating Board getting together to define the general areas of responsibility to prevent duplication.

The problem has been to continue the cooperation at the working level. John H. Rubel, deputy director of defense research and engineering, recently told a hearing of the Senate Space Committee that "we've been successful in making policy and dividing responsibility, but we have had a little more difficulty in coming down to specifics."

"We are coming to the point," he said, "where broad policy is not as important as making detailed decisions and working out arrangements in which the military research capability can be made available to the space agency."

Top-drawer responsibility for determining in what areas the cooperation will take place remains in the hands of McNamara and the Director of Defense research and engineering.

• **Picking vehicles**—The settling of top policy questions between NASA and the DOD—which has been handled so successfully in the past—is the province of the joint Aeronautics and Astronautics Coordinating Board.

Besides establishing broad areas of authority for each agency in space, one of the board's prime accomplishments was the decisions as to what launch vehicles would be built by both agencies for space missions.

The so-called "Golovin" launch vehicle committee was an outgrowth of the Board. Its decision resulted in the approval of the Air Force's *Titan III*, and NASA's advanced *Saturn* and *Nova* launch vehicles.

The Board—headed by co-chairman Dr. Hugh L. Dryden, Deputy NASA Administrator, and Dr. Harold Brown, Director of Defense Research and Engineering—has four primary areas of responsibility:

1) Planning activities by NASA and DOD to avoid undesirable duplication and to achieve efficient utilization of available resources.

2) Coordination of activities in areas of common interest of NASA and DOD.

3) Identification of problems requiring solution by either NASA or DOD.

4) Exchange of information between NASA and DOD.

The board meets about every six weeks or whenever special meetings are required. No formal votes are taken at meetings and no decisions are finalized.

From this board have come the major agreements for NASA-DOD cooperation. Especially important are the six specialized panels which have been set up to settle specific problems in various program areas. The panels cover Manned Space Flight, Unmanned Spacecraft, Launch Vehicles, Space Flight Ground Environment, Supporting Space Research and Technology, and Aeronautics. ⌗

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ments between NASA and DOD. In the discharge of these responsibilities, the Director of Defense Research and Engineering will coordinate with and secure the assistance of the Secretaries of the military departments, the Joint Chiefs of Staff, the Assistant Secretaries of Defense, the General Counsel, and the heads of other DOD components as necessary. The Director, Defense Research and Engineering, will review all implementing plans for consistency with basic agreements between DOD and NASA.

C. The Assistant Secretary of Defense (Comptroller) will coordinate the financial arrangements between NASA and DOD within the framework of basic agreements entered into by the Administrator, NASA and the Secretary of Defense.

D. Except as the Secretary of Defense may otherwise direct, the Secretary of the Air Force is assigned responsibility for the research, development, test, and engineering of satellites, boosters, space probes, and associated systems necessary to support specific NASA projects and programs arising under basic agreements between NASA and DOD.

E. Responsibility for DOD support of other aspects of specific NASA projects and programs arising under basic agreements between NASA and DOD shall be assigned to appropriate DOD components by the Secretary of Defense upon the advice of the Director of Defense Research and Engineering, who shall consult with the Secretaries of the military departments, the Joint Chiefs of Staff, and the heads of other DOD components as appropriate in preparing specific recommendations.

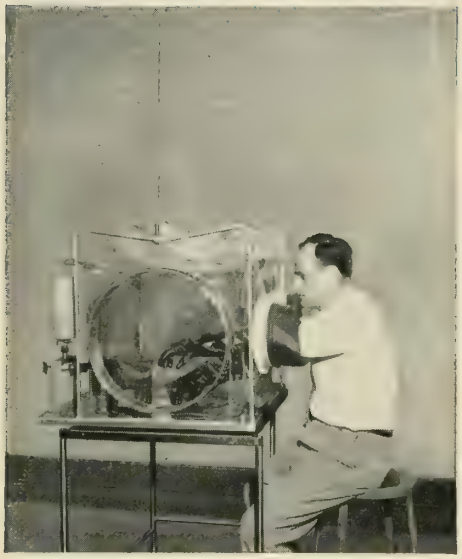
F. The Secretary of the military department or head of a DOD component assigned primary responsibility to support specific NASA projects and programs, or aspects thereof, by the Secretary of Defense is responsible for the detailed project level planning necessary to implement his assigned responsibilities. In addition, he is responsible not only for establishing and maintaining such contracts and management arrangements with NASA as are necessary to carry out such programs and projects but also for coordinating with other DOD components whose facilities and resources might be involved.

G. The Secretary of each military department or head of a DOD component shall report monthly to the Secretary of Defense on the status and progress of all implementing plans, programs, and projects for which he is responsible. A copy of such report shall be furnished the Director of Defense Research and Engineering.

ROBERT S. MCNAMARA
Secretary of Defense

Amsco

DEVELOPMENT FACILITATES STERILIZATION AND TESTING OF SPACE PROBE COMPONENTS



The apparatus illustrated was devised by American Sterilizer Research and Development to meet the requirements of a project undertaken for the National Aeronautics and Space Administration by the U. S. Chemical Corps Biological Laboratories, Fort Detrick, Maryland.

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Complete data and procedures are covered in a paper presented by L. L. Reed, R. R. Gidner and H. S. Dinger. Reprints are available upon request to American Sterilizer Research Division.

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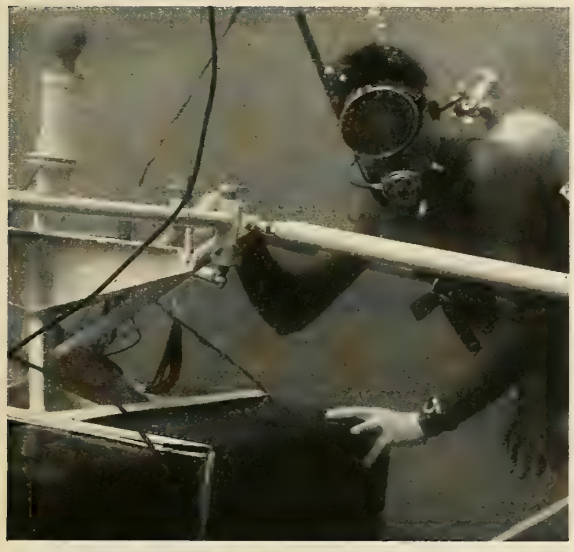

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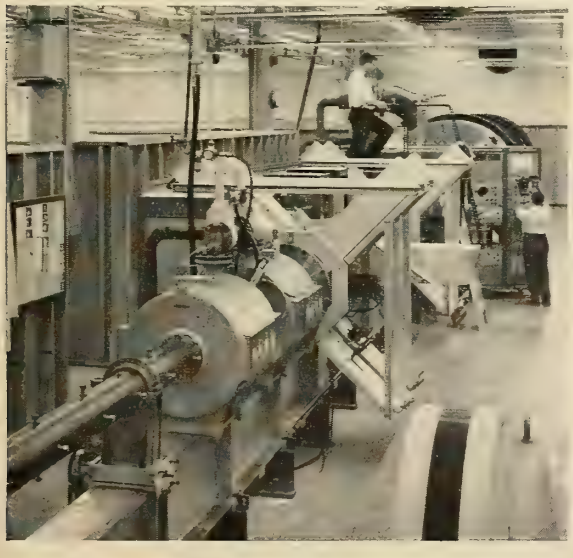

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Trend Toward $14-16 Billion by 1970

***Army has Advent, Navy has Transit, both have other interests—
but Air Force dominates market and may spend $15 billion through decade***

TOTAL MILITARY SPACE electronics expenditures from FY '62 through FY '70 are expected to be from $14-16 billion, according to conservative industry estimates.

These estimates are based on changing strategic and defense requirements, not on a marked increase in Department of Defense budget authorizations.

Forecasters see two distinct trends over the next 9-year DOD spending period. First, the ratio of RDT&E-to-procurement expenditures is expected to rise steadily. Second, both missile and aircraft electronic production expenditures are expected to drop steadily while the electronic space market curves continuously upward. (See Tables 1 & 2.)

• **The Army communicates** — The venerable Signal Corps directs the Army's single space task: the development of active communications satellites.

The Signal Research and Development Laboratory at Fort Monmouth, N.J., directs the *Advent* program. It is supported in varying degrees by the Ordnance Corps through Piccatinny Arsenal, Aberdeen Proving Grounds, Diamond Ordnance Fuze Lab., and the Army Ballistic Missile Agency.

Fallout from the Signal Corps' extensive microminiaturization program and applied research in the semiconductor field will undoubtedly find its way into the space program. The same holds true for Army Ordnance. It has a strong capability in the development of fuses, counters, programers and guidance and control subsystems.

Both White Sands Missile Range and the Electronic Proving Grounds at Fort Huachuca can provide specialized support for testing and instrumentation.

Now under way at the Army's Signal R&D Lab. at Ft. Monmouth are several projects aimed at increasing the military's space communications capabilities. The Lab also is placing a heavy emphasis on reliability, long on-the-shelf and operating life and shock and vibration resistance for spaceborne electronic gear.

The Signal Corps currently is working closely with several electron tube manufacturers towards advancements in the traveling-wave-tube state of the art. These devices, which probably will go aboard advanced *Advent* satellites as rf power amplifiers, are thought by many to have broad application in both microwave transmission and reception systems. The Army need is for lightweight tubes that can operate at relatively high voltage-efficiencies for long periods of time in a special environment.

Army interest in lasers is also quite heavy due to the obvious satellite-communications, ranging, and special-purpose illumination applications. Scientists at the Lab, who recently demonstrated a new 3-megawatt pulsed laser, are reportedly at work developing early intelligence-modulation schemes for the laser beam.

Improvement in long term stability and resistance to shock and vibration extremes of frequency control crystals is also attracting Signal Corps attention.

• **Navy navigates** — The largest space effort closely associated with electronics being carried out by the Navy is its *Transit* navigation-satellite program. Other electronic areas of current Navy interest include space environmental studies, bioastronautics, space telecommunications, and geodetic-satellite studies *(Anna)*.

The Navy over the years has built up a large electronics in-house capability. With its background in developing communications systems, navigational aids and fire control systems, it could probably support any electronics-oriented development project.

In addition, the Navy was the first service to set up and maintain a long-range electronic components quality control program. Its first fundamental reliability studies were begun on a broad scale about 1949.

The extensive laboratories of the Bureau of Weapons, the vast scientific and engineering capability of the Office of Naval Research, and the many Navy test facilities scattered across the country lend support to the Navy's continued attempts to broaden its space assignments.

(For a look at the Navy's instrumentation facilities and future requirements, refer to the Pacific Missile Range story on p. 128.)

• **But AF controls space**—A look at current and planned Air Force expenditures leaves little question as to who will dominate the future military space electronics market.

A reasonable assumption is that 45-50% of Air Force space funds between now and 1970 will go for space electronics—roughly $13.5-15 billion. Air Force in-house effort is difficult to pin down, but it probably runs between 10 and 15% in dollar requirements.

Space electronics is coming in for strong emphasis since estimates of Air Force expenditures (see table) indicate an increased emphasis on intelligence-gathering space systems. About one-third of the future AF R&D budget, at least for the next 9-10 years, will be for such systems.

It will be noted that only two L-type command and control systems are shown in the table. These are completely related to space. Of the seven existing L-systems partially associated with space, five are intelligence-type systems and the other is a communications system.

If the space-associated L-systems also were added to the AF space totals for the period through FY '70, the overall electronics figure would approach $17 billion. This total could also, of course, be much reduced as concepts and requirements shift.

Weapon systems rely heavily on command and control to provide a successful weapon. Electronics is a vital tool for this support. Surveillance, reconnaissance, communications, and navigation space vehicles are flying laboratories of electronics systems and also are supported on the ground by vast complexes of other electronic equipment.

Air Force in-house research and its continuous R&D effort through industry over the past 10 years are beginning to pay off now. Its broad electronics R&D program now in effect offers a glimpse of the future trends in systems development.

• **Air Force RDT&E**—Space does not permit a complete breakdown of the multitude of current AF space-oriented R&D efforts at all the various installations.

In general, however, Air Force electronics R&D is split up as follows:

—*Electronic Systems Division*—All of the command and control systems and technologies supporting them including communications, data processing, intelligence, displays, tracking and detection are handled by ESD. To further generalize, ESD's responsibility is primarily over ground systems and includes range instrumentation.

It performs the advanced planning and applied research necessary to conceive and determine requirements and prove feasibility of new systems. It makes use of other Air Force work agencies for the applied research necessary in hardware development and systems testing.

The 1962 budget for ESD was in excess of $850 million. Support for the L-type command and control systems alone was over $500 million. Its major space system is 496L, Space Track. Six other L systems are associated with the space effort. Total funding for these approaches $400 million.

The Deputy for Technology at ESD is responsible for performing applied research in electromagnetic wave techniques, computer and data processing techniques, surveillance techniques, communications techniques, electromagnetic vulnerability reduction, intelligence techniques, and associated electronic techniques. Its current research effort totals $115 million.

The Mitre Corp., ESD's not-for-profit technical associate, is currently funded at about $30 million. It supports ESD in all tech areas.

A continuous problem at ESD is the integration of all its command and control systems. Originally, these began as separate entities. Now, the complete integration of all L-systems is seen as a desirable goal.

For the future space effort, ESD long-range planners are developing the concepts for launch control recovery, space control and surveillance support. The approach entails a combination study of environment and functions.

—*Rome Air Development Center*—Electronics applied research and development primarily in ground-based electronic systems and equipment, comprise the principal responsibilities at RADC. Thus it is a key RDT&E work agency for the Air Force.

Its current R&D budget of over $95 million is largely for non-space electronic work. It does, however, have a steadily growing interest in the field.

In varying degrees, RADC supports ESD in the hardware development of most of the L-systems.

The Directorate of Guidance and Control provides major developmental assistance on 473L (data processing and display control system for command decision) and played a major role in R&D for SPADATS, Space Detection and Tracking System, around which 496L (Space Track) will be built.

Major areas of interest include all facets of infrared and radar detection and tracking, including advanced antenna development, data handling techniques, and spacecraft ground guidance and control; high power breakdown phenomena and techniques for the controlled use of destructive radiations; and highly advanced r-f tube configurations.

G&C Directorate is placing increased emphasis on millimeter waves and the optical portion of the radio spectrum for space use. Finally, it now has programed a major study effort toward future space problems and potential threats.

Programs in the Directorate of Intelligence and Electronic Warfare fall roughly into two groups: 1) R&D of electronic countermeasures and countercountermeasures equipment; 2) information processing, particularly with respect to intelligence systems. Its largest effort is techniques support for the 466L program (Electromagnetic Intelligence System) for ESD.

Advanced R&D areas in the Electronic Warfare Lab include intensive radio propagation studies and fundamental plasma research.

The Information Lab supports all L-systems involving data processing. Its other advanced R&D areas include studies of multi-sensor approaches to reconnaissance interpretation and the entire field of man/machine relationships in data processing.

The Directorate of Communications' mission is the performance of RDT&E of new or improved techniques and equipments for use in Air Force Communications systems. Because of its broad communications capability, it takes part in systems integration for all Air Force L-systems and weapon systems.

It is responsible for the Air Force's role in passive communications satellites in the development of advanced ground systems.

Other major tasks include antenna development, advanced communications techniques in space, and the application of laser technology for data transmission. (An attempt will be made in the future to investigate the possible use of an optical-frequency system with the *Echo II* satellite.)

The Directorate anticipates spending from $300-400 thousand a year on laser development contracts.

The Engineering Directorate of RADC supports the other directorates and is primarily responsible for data display development and for systems reliability. Forty percent of its total effort is performed in-house.

Other areas of current research and development interest include solid-state devices, exotic energy sources, transmission and interaction characteristics of r-f energy in the very high frequencies, and

Table 1—Estimated DOD Expenditure Trends from 1962-1970 Inclusive

(In Billions)

	1962	1966	1970
TOTAL DOD:	$43.5	$48.0	$48.5
RDT&E	4.5	7.0	8.5
Procurement	14.5	13.0	15.0
Other costs	24.5	28.0	25.0
Space	1.0	3.0	6.5
Missiles	6.0	5.0	4.5
Aircraft	6.5	4.0	3.5
Other programs	30.0	36.0	34.0

Table 2—Comparison of NASA and DOD Space Expenditure Trends

(In Billions)

	1962		1966		1970	
	Total	Avail. to Industry	Total	Avail. to Industry	Total	Avail. to Industry
NASA	$1.8	$1.4	$5.5	$4.4	$4.9	$3.9
DOD	1.0	0.7	3.0	2.6	6.5	6.0

Table 3—Breakdown of Predicted Air Force Expenditures Associated with Electronics RDT&E and Procurement

(In Millions of dollars)

	'62	'63	'64	'65	'66	'67	'68	'69	'70	TOTAL
Dyna-Soar	95	95	45	25	12	?	?	?	?	272
Discoverer	30	45	45	25	15	—	—	—	—	160
Global Surv. System	8	17	27	115*	180	285	375	325	270	1602
Midas	95	100	105	160	180	135	120	60	50	1005
Samos	130	122	135	170	145	135	145	47	35	1064
Satellite Inspect. System	10	40	60	100	130	150	165	125	105	885
Bambi (anti-ICBM) Satellite	5	10	25	60	160	250	400	550	750	2210
Orbital Weapon Systems (2)	5	12	25	50	140	245	320	430	435	1662
Military Test Space Station	—	3	5	17	22	75*	130	165	175	592
Slomar	—	—	—	15	80	220	285	345	385	1330
Space Command & Control System	—	—	30	30	30	50	100	170	200	610
Space Track (496L)	60	80	60	100	100	100	120	100	75	795
Military Lunar Base	—	—	—	—	5	5	10	20	37	77
Test Instrumentation	25	50	100	100	120	120	120	120	120	875
Misc. Applied Research	12	25	50	75	75	75	100	100	100	612
TOTAL	475	599	712	1042	1394	1845	2390	2557	2737	13751

*Includes follow-on, beginning fiscal year indicated.

personnel radiation hazards.

—*Avionics Directorate, ASD*—The third major Air Force group for electronics R&D is the Avionics Directorate, one of five major operational organs of the Deputy Commander/Technology at Aeronautical Systems Division.

Over 70% of Avionics' total R&D effort is devoted to the space effort. Current funding for R&D exceeds $60 million: EW and Communications Lab. —$15 million, Navigation and Guidance Lab.—$20 million, Recon. Lab.—$16 million, and the Electronics Technoloy Lab.—$9 million.

In the Nav. & Guidance Lab., 60% of the effort is for space, 20% aeronautics, and 20% for applications capable of use in either field. The only Air Force flight navigation and control lab, it has responsibility for all such requirements in the Systems Command.

Current R&D efforts include all types of advanced inertial and stellar-inertial components and systems, and flight programers and data processors. The group is currently studying problems and developing requirements for satellite and lunar vehicle guidance techniques, lunar and space flight systems, and aerospace intercept and rendezvous.

In the EW and Communication Lab., the total space R&D effort is relatively small since a majority of its programs are for ECM, ECCM, and related propagation studies for missile and aircraft flight systems.

Its space-associated R&D includes re-entry plasma studies (blackout problems), airborne communication satellite techniques, a variety of advanced space vehicle antennas, optical communication for space-to-space use, state-of-the-art telemetry subsystems, data conversion systems and transducers.

The group also is developing advanced techniques for data compression, insertion and display, and is seeking approaches to vastly increased transmitter efficiencies. It also has a small program for the study of unconventional communications. This is an attempt to understand and make use of the communication processes employed by animals and insects.

Much of the work in the Reconnaissance Lab is highly classified, as might be expected. Over $10 million of its $16-million R&D funding is for recon systems. The remainder is for development of new photographic films, components and processes or electro-optical sensors and detection techniques (for *Samos*- and *Midas*-type systems).

Two major efforts by the Lab have been the R&D for an optical space surveillance sensor and an optical radar system. The former employs a telescope having a 48-in.-dia. mirror and a 26-ft. focal length as a research tool. A million-dollar program now, it will exceed $2 million eventually.

A continuing program is the development of high-resolution terrain reconnaissance systems for orbital or other space vehicles. These will employ image orthicon and TV for real time or delayed transmission to ground stations.

The Electronics Technology Lab is working toward more fundamental research in materials and components applied research. It is not mission-oriented.

Major efforts here are in thermionics, molecular electronics and bionics. Other R&D projects include plasma diagnostics, thin-film deposition, ion bombardment (sputtering effects), solid-state components, high- and low-power microwave tubes, sensor and display tubes.

—*Missile Development Center*—The Central Inertial Guidance Test Facility is located at the AF Missile Development Center, Holloman AFB. Its chief mission is to provide standardized development testing of all Air Force guidance and control systems.

CIGTF often enters the system development picture at the contract stage by helping to determine system requirements and test parameters.

It often performs inertial component tests for manufacturers. Later it performs laboratory tests of subsystems, then sled tests, and finally flight tests. The group performs its own data analysis.

A new CIGTF addition that may find use in future space programs is the stellar-inertial test complex. Studies have been completed and the facility is scheduled for completion by the end of 1963.

—*Space Systems Div.*—Last, but by no means least, of the Air Force groups associated with space electronics is the Space Systems Division.

Since it has management responsibility for the development of all Air Force space systems, its electronics capabilities are extensive. (For a complete review of SSD's programs and growth trends, see p. 94 of this issue. ■

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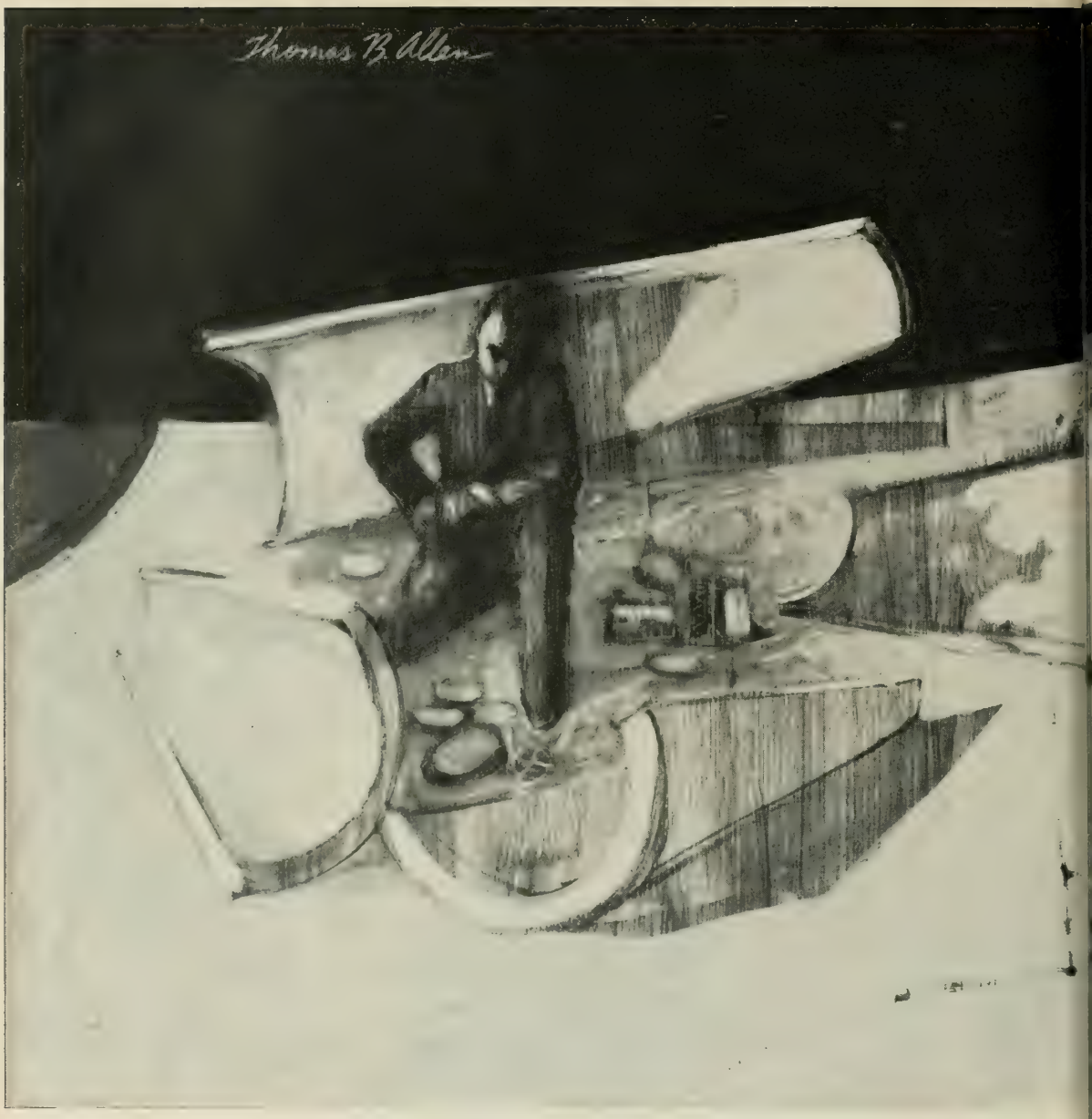


THE SKEPTICAL MEN

"...habits," wrote John Dryden, "gather by unseen degrees,—
As brooks make rivers, rivers run to seas."

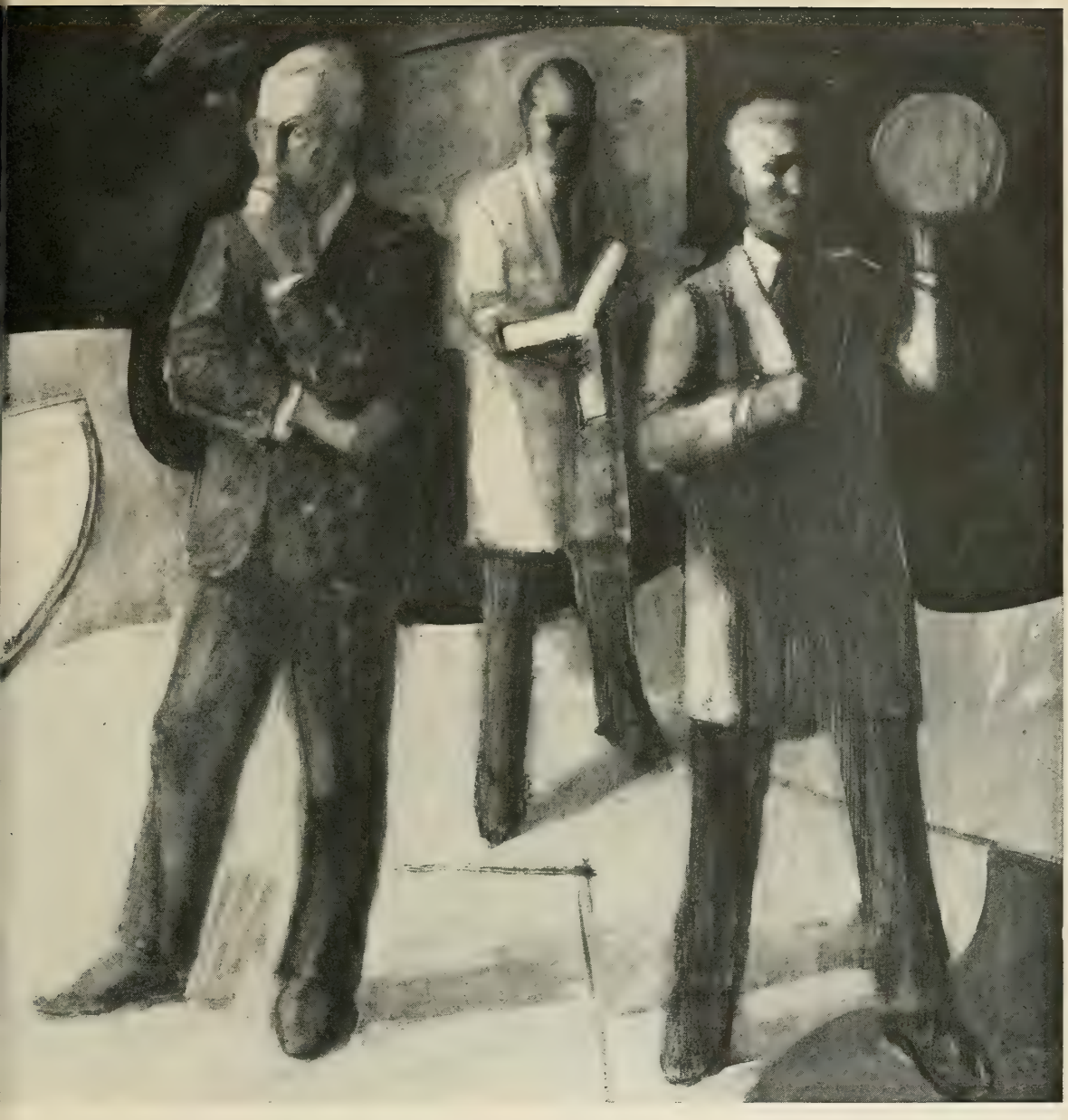
All men are susceptible to the accumulation of habits. It's a natural part of our lives to do things with a certain repetition.

But in industry, accepted ways of doing things, based merely on repetition, can prove expensive.

Because of the complexity of projects carried out by the aerospace industry, it has been looking with increased skepticism on accepted methods of doing things. As a result there have arisen whole new approaches within management—approaches fulfilled by men in value analysis, quality control, product reliability.

These men, working together, and working closely with engineers and purchasing agents, help cut needless expense while maintaining and increasing high levels of reliability.

Some of the questions they ask are: "What is the item?" "What is the function?"



"What does it cost?" "What else would do?" "What would that cost?"

Questions such as these may sometimes make their work difficult in the area of human relations, but as the scope of the work is better understood these problems decrease. For this new approach is more than just mere cost consciousness. It is a highly creative method that allows management to overcome roadblocks of pre-conceived ideas.

Analysis of function is now spreading to every level of production—from top management to the design engineer to the purchasing agent to the man on the line.

This is one of the ways the aerospace industry is helping America get the most for its defense and space money. It has already paid off in millions of dollars saved.

This is the work of men who are not willing to accept the accepted.

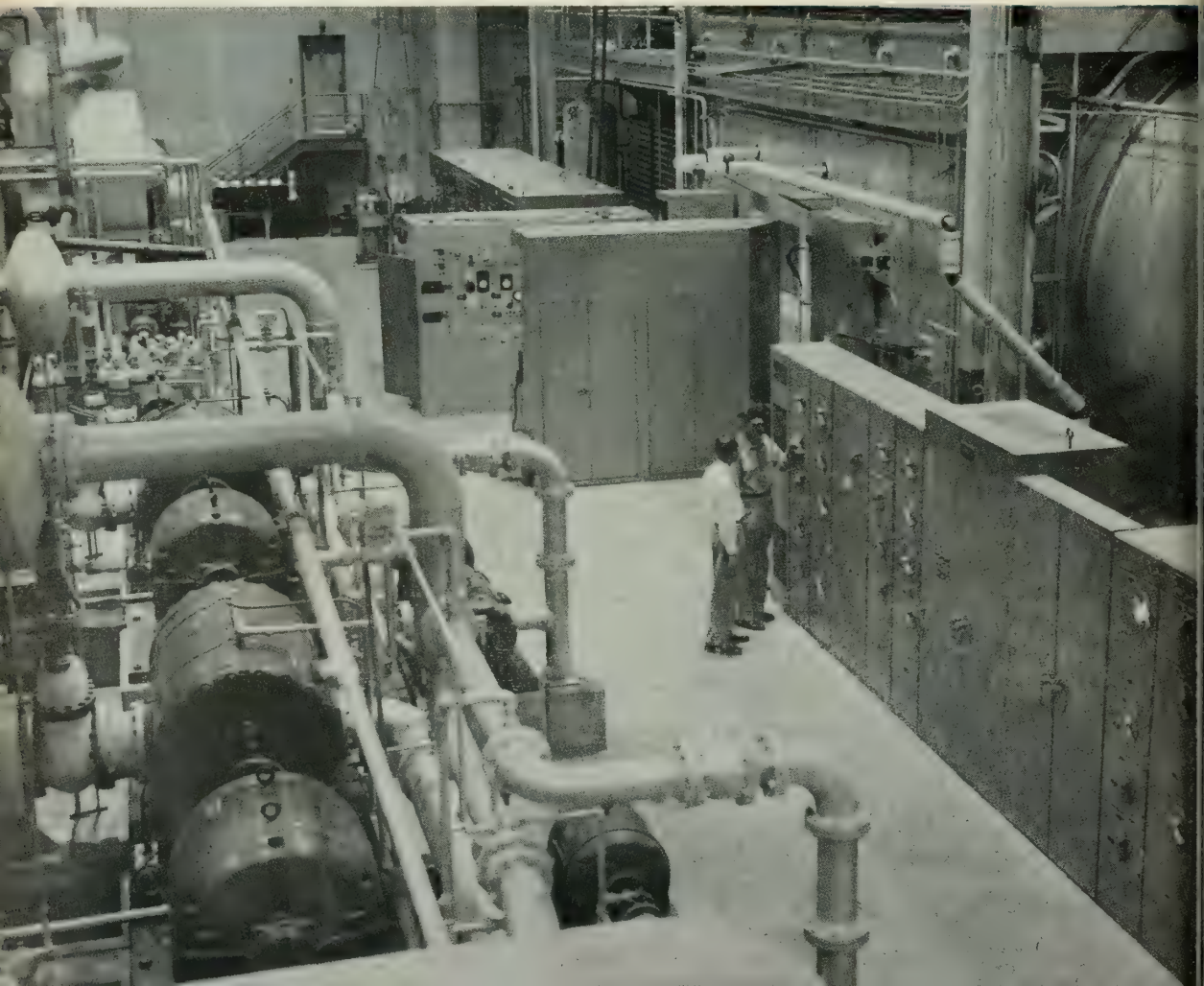
This is the work of the skeptical men.

North American Aviation is at work in the fields of the future through these six divisions: Atomics International, Autonetics, Columbus, Los Angeles, Rocketdyne, Space & Information Systems

An $8-billion Investment by 1970?

Industry experts see this as cost of developing all needed propulsion technology of all types; Titan III solid-liquid booster viewed as 'Space Age DC-3'; a survey of all research fields

VACUUM PUMPS and low-density wind tunnel in the Directorate of Engineering Test, Deputy for Test and Support, AF's Aeronautical Systems Division.



MILITARY BOOSTER and propulsion technology development may easily cost more than $3 billion over the next eight years, industry analysts predict. This includes solids, liquids, nuclear, electric, storable and mixed concepts.

While military and civilian needs are similar in a general way, there is a sharp difference in certain particular areas.

For instance, the Air Force must have a fast-reacting booster capability and higher degrees of maneuverability to perform routine military missions in space.

There is a high degree of cooperation between the Air Force and the National Aeronautics and Space Administration in the booster category. NASA has been dependent upon the Air Force-developed *Atlas* for some of its missions. The soon-to-be-operational *Titan II* system will be part of the two-man *Gemini* project and *Titan III* may be used by NASA. But the space agency is rapidly building a liquid booster capability in the *Saturn* series.

Nuclear rocket technology is primarily in the hands of NASA and the Atomic Energy Commission, but the Air Force is in constant touch and funds corollary projects.

The AF Large Solid Booster program is aimed at providing the basic technology needed to increase payload capacity in future space systems.

There is also funding directed toward development of the *"Aerospace Plane"*—a hydrogen-powered, air-breathing vehicle capable of ground-orbit-ground performance. This propulsion system is slated for the 1970's.

Getting back to the near future, there is some talk about a *Titan II-Agena* system to carry on the routine data and systems studies so well handled by the current *Discoverer* program, but with an increased payload ability.

• **Space Age workhorse**—The so-called *Titan III* solid-liquid booster is expected to be the DC-3 of the Space Age—both in dependability and useful lifetime as a system.

It is very difficult to forecast beyond the *Titan III*. It is regarded as a workhorse vehicle with a very extended life—perhaps 10 years.

For companies looking for sale of new products, this perhaps is disappointing, but looking at its from a program angle—missions—here it would appear that *Titan III* offers industry a chance to participate in a program of unusually long duration. Where the *Thor* buyout was completed in two years, the *Titan III* buyout would be over a decade.

The booster will be based on existing technology and great stress is being placed on good management. DOD insists the program must achieve the specified objectives within the cost estimate.

In line with these objectives, a program office has been established unique in BSD-SSD and, possibly, in the Air Force. This office has, within itself, all the functions required to manage the job.

Only Phase I approval has been granted. This covers a detailed planning stage aimed at a vehicle completely defined—and accurately priced.

• **Program crystallization**—Through the solicitation of proposals for solid motors and guidance systems, the Air Force is completing the contracts structure. Objectives of Phase I in the *Titan III* program include firming the vehicle and facility configurations, determining the scope of the program, identifying the technical risks and establishing the managerial organizations, appropriate controls and contract structure.

The guidance system for *Titan III* will have to be new—but not "new" in the sense of pushing the state of the art. The AF hopes to avoid any such effort, and sees the concept as having very conservative design. Reliance on proven technology is the theme.

The booster will be used for *Dyna-Soar* and other programs. Intentionally flexible, it will take anything from very heavy weights in low orbits to lighter weights with higher escape velocities.

The *Titan III*—or *Soltan*—is expected to have the capability to place 12.5 tons in a 300-mile orbit. The vehicle will use two strap-on solid motors, each 120 in. in diameter and segmented for flexibility. Each of these will have a maximum thrust in the 1-million-lb. area. The propellant cores will burn regressively, dropping the thrust down to about 0.5 million lbs. at burnout.

Basic vehicles will be modified Martin *Titan II's*, using storable liquid propellants. Both stages will use UDMH-Hydrazine as fuel and nitrogen tetroxide for the oxidizer.

One initial mission under consideration is a 24-hour orbit. The *Titan III* will put several thousand pounds in this type of orbit. Part of the flexibility will come from a planned four-flight configuration through the basic building blocks—*Titan II* and 120-in. solids together with high-energy upper stages in various combinations.

• **Backpedaling solids**—In the big solid booster area, the Air Force is to conduct the development program under a NASA-DOD agreement—assuming the first applications would be for the lunar mission. At about the time this agreement was being made, DOD was evolving the concept of a family of standardized launch vehicles and asked the Air Force to perform studies as to size and other characteristics.

But, when the Golivan committee had finished, the large solid motor disappeared from consideration as a direct and parallel alternative to the liquid engine for the *Apollo* mission.

While the first application of "large" solids is in the *Titan III*, development of bigger motors is being initiated. The Air Force is in the process of submitting proposed programs to meet DOD and NASA agreements in very-large solid motors.

The main AF work on propulsion systems is performed at Wright-Patterson AFB in the Aeronautical Systems Division, and at the 6593rd Test Group of Space Systems Division at Edwards AFB. ASD is involved in electric and nuclear ramjet programs, while the 6593rd handles chemical and nuclear rocket research.

The electrical devices under devel-

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opment and study cover all three major concepts—electrostatic, electrothermal and magnetohydrodynamic. All details of the work, in-house or on contract, are classified.

Cesium ion engines have been under study at Electro-Optical Systems Inc., for nearly two years; a laboratory demonstration model has been delivered to ASD. The Air Force sees this engine type as applicable to long-duration missions.

Work in surface physics involving ion formation is in progress, and other efforts are aimed at increasing current density, cutting stray losses and determining control schemes.

United Aircraft Corp. is concentrating on evolving an oscillating electric-ion source and a neutral plasma electrostatic accelerator. Plasmadyne Corp. is under contract to ASD to demonstrate, in the laboratory, that an arc-jet engine will have the necessary efficiency and lifetime to best place a satellit in a synchronous orbit.

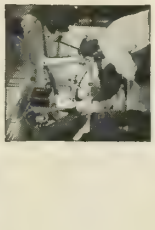
Marquardt Corp. will complete ASD-funded studies this year on electrothermal engines for earth-orbital transfers, satellite attitude control and orbital inclination changes.

Earth-moon logistic transport in electrothermal engines is being studied by Aerojet-General's Nucleonics Division.

Less information is available in the ramjet area, nuclear or otherwise. Progress has been made in thrust vector control, throttling and cut-off. Efforts have been concentrated on improving the rupture disks near the throat.

There is some indication that one promising approach to ramjet improvement lies in the possible combination of a ramjet with a turbofan—taking advantage of lower weight, advanced blade damping and installation techniques of the turbofan.

ASD is funding limited studies in this area, but interest in ramjets is high, primarily because of the lack of oxidizer tankage.



• **Edwards to space**—The propulsion mission-direction of the 6593rd Test Group is twofold—development of propulsion systems for military weapons and the near-parallel development of the same system for space applications. The Group treats these areas as different, but very close liaison is maintained.

The Group considers itself the prime Air Force engineering organization in the rocket field. Outside of its in-house work for SSD, it provides engineering support to Aeronautical Systems Division for *Dyna-Soar* and other projects.

Basic responsibility for the Air Force segmented-booster program lies with the Group, and the feeling is that big segmented solids look good for

ION ENGINE in test chamber of Propulsion Laboratory, Directorate of Aeromechanics, Deputy for Technology, ASD.

single-stage boost to orbit.

About 80% of the Group's budget is going into storables. A large in-house effort is being expended on thixotropic fuels. The main interest is in producing satisfactory jells and the application of new ingredients as they arise.

The Group is studying both basic jells and new energy-producing additives. Space applications for the jells look good, since the high power availability really pays off, says the Group. There is also the safety factor of jells.

Liquid and solid attitude control systems are under investigation. These would have power levels on the order of 0.1 to 1.0 lbs. thrust usable for periods of 10 microseconds or, perhaps, 2 milliseconds.

The Air Force requirements in maneuvering propulsion are varied—from around 5000 lbs. to 40,000 lbs. thrust. The Group says there are very large power requirements in this area but these are "down the road" at present. These exceed existing chemical propellant technology. The Air Force is looking for something far beyond the X-15/XLR-99 variable ratio for future maneuvering requirements—about ten times currently available ratios.

In connection with this, the Group is working on low-chamber-pressure engines—both in-house and under contract. Such systems will have to be light and simple, using very low propellant feed and low combustion chamber pressures. Injector design plays a big part in the development.

The same general area includes restart and variable thrust—and the injector design again holds the key to success. The main difficulty is a lack of definition as to how many restarts will be required. A criterion is needed to

determine the best design.

In variable thrust, the thinking is in terms of at least a 25:1 ratio. This is a minimum need for control of closure rates. An alternate approach is a pulsed on/off engine, but this creates other problems. The Air Force is convinced either type of system is a must for military space system.

The Air Force believes that all such developments, when successful, should be continued into a range of sizes—so whatever is needed can be available when it is needed.

The Group says solids are having a hey-day. They feel a worthwhile plateau is being achieved with I_{sp} ratings of 240 and 0.9 mass fractions.

The technology is moving further into an I_{sp} range between 240 and 260. The Group is looking for an increase in I_{sp}. State of the art is currently between 240-250 I_{sp} and .85 to .95 mass fractions.

There is some feeling I_{sp} is being overstressed, since it is only one portion of a system's performance. Upper-stage I_{sp} and mass fraction techniques are quite well advanced, the Group feels, and the knowledge is at hand to build some good performing vehicles for specific applications. Work is progressing on high-expansion ratio nozzles which will increase over the 40 to 50:1 ratios of today by a factor of 4—hopefully, a factor of 10.

• **Maneuvering**—Both liquids and solids look promising for attitude control, with the solids coming up fast. Space maneuvering with liquids still looks best for upper stages, but a combination is also quite promising. Liquids have the flexibility, but variations of solids can be built far faster.

In overall booster work, the Group feels sure that a chemical equivalent of nuclear stages will be feasible during the next five years, and there will be a major breakthrough in chemical propulsion.

The use of rendezvous techniques may help knock down the requirements for really big boosters by developing high-performance upper stages. This could be done with segmented solids. But the technology is now such that, if necessary, engines larger than the F-1 could be built by 1970.

The primary approach pursued in both liquids and solids—in terms of thrust vector control—involves the use of secondary injection fluids. Both hot-gas and reactant liquid methods appear promising, depending on the particular application or engine.

In space systems, the Air Force is aiming at a goal of one-year storability in space by 1965. All that could prevent this from becoming reality would be the structural weight penalty associated with meteoroid protection. ⌘

NEW CAREER POSITIONS WITH PAN AM AT CAPE CANAVERAL

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ASD's Materials Central guides contractors' work, maintains close links with technical community

ONE OF THE LARGEST and most complex attacks on the whole gamut of materials for space applications is being waged by the Directorate of Materials and Processes (Material Central), Aeronautical Systems Division of the Air Force Systems Command.

Commanded by Col. Lee Standifer, the organization handles the broad ASD-Air Force responsibility for applied research in materials. Its programs are oriented to encourage and supplement the national research effort, with primary emphasis in those areas of maximum potential pay-off to the Air Force.

The highly trained in-house working force accounts for about 10% of the Air Force materials research dollar—the rest moves through Materials Central out to industry, universities and non-profit research institutes.

Although equipped with over $5 million worth of research apparatus—and more in facilities, the Directorate's most critical task is in the difficult area of research management. The vast in-house effort is used to guide the many contracted research programs in a manner flexible enough to allow for the constantly changing requirements of the U.S. Air Force—in effect of the whole defense picture.

This calls for not only the classical R&D management, but also extended excursions into the huge field of manufacturing technology. A development cannot prove to be a dividend until it is incorporated itno a weapons system.

This adds a much more complex function to Materials Central. Bridging the gap between the laboratory and the production line is a prime factor in planning and one of the prerequisites for any new missile/space development.

• **National network**—The scientific complement at Wright-Patterson AFB is an integral part of the U.S. technical community. Men from Materials Central are constantly attending technical meetings, making personal contacts and discussing the many particular problems common to specific technical fields.

This is one example of how the Air Force is attempting to solve one very major problem—the task of directing research with a minimum amount of unnecessary overlap between basic and applied programs.

Another means is through information and data dissemination. For example, a Graphite and Ceramics Information Center is being established at Wright Field to afford a measure of control over a rapidly growing and highly crucial aspect of aerospace materials development.

Some of the major problem areas are outlined below, but this represents only a skeletal description of the entire materials effort. The main theme is time-temperature; only those developments necessary to space tasks are mentioned in any detail. It should be evident that almost every program has a dual effect—covering both "limited war" and advanced systems. The programs are so directed as to always keep them in line with the overall Air Force mission.

The main problem with refractory metals is the catastrophic oxidation which occurs above 1200°F. A vast effort is being made to find protective coatings for molybdenum, columbium, tantalum and tungsten.

The main emphasis is on reliability. This is a critical problem associated with glide re-entry vehicles.

In the general area, the best coatings developed so far are:

—Columbium: chromium titanium, aluminide, silicides.

—Tantalum: aluminide, silicon.

—Molybdenum: nickel-zirconia, nickel-silica.

There is no known coating which the Air Force considers satisfactory for tungsten alloys. None of the coatings evaluated to date are really considered to be of optimum composition. Methods of application—such as pack cementation, slurry, vapor deposition or electrodeposition—have not worked out to Air Force satisfaction. In many cases, the effect that the coating will have on the base metal after long periods of elevated temperature is unknown.

As for the refractories themselves, the molybdenum and columbium alloys are in a more advanced state of development, with the moly alloys in the lead. In both alloys, the mechanical properties are controlled by strain hardening and recrystallization. Research is progressing on columbium-based alloys which depend on dispersion or precipitation-hardening for strengthening purposes.

Besides coatings, oxidation protection through alloy additions has also been tried. Alloys showing considerable improvement in this area have been made, but these lack the elevated-temperature mechanical properties of the other alloys.

Also hindering the use of these alloys are the difficulties in composition control during melting and fabrication. Lack of uniformity in the product, and inability to control the tolerance of the sheet stock to the desired limits, also plague these compositions.

Beryllium's brittleness continues to be a major problem in the pure metal and its alloys—even though designs have circumvented the problem in some cases.

Various compositions of titanium-base alloys are being evaluated by the Materials Directorate. Since this metal exists in two crystallographic forms and has a solubility for numerous metals, many alloys of different characteristics aimed at specific applications are possible.

Titanium alloys containing aluminum and columbium show some possibility for use at 1600°-1700°F. The Air Force characterizes oxidation resistance of these alloys as "good to excellent."

The rare earths have been screened for possible use but the results do not indicate a great potential in structural applications. Some will probably be of value as alloying agents—yttrium and erbium improve the oxidation resistence of columbium, for example. Sufficient information is not available to permit determining the worth of the rare earths in specializing non-structural applications.

The Air Force is pushing research in another area—the superalloys—with an eye towards developing alloys suitable for use in the 1900°-2000°F temperature range. This would permit their substitution for refractories with accompanying weight savings.

• **Basic considerations** — A large amount of ASD's research and development in metals is more fundamental. Examples include work on precipitation and dispersion-hardening, effects of ultra-high pressures on metallurgical processes, the plastic deformation of metastable austenite, and the heat treatment under unconventional conditions—in a strong magnetic field.

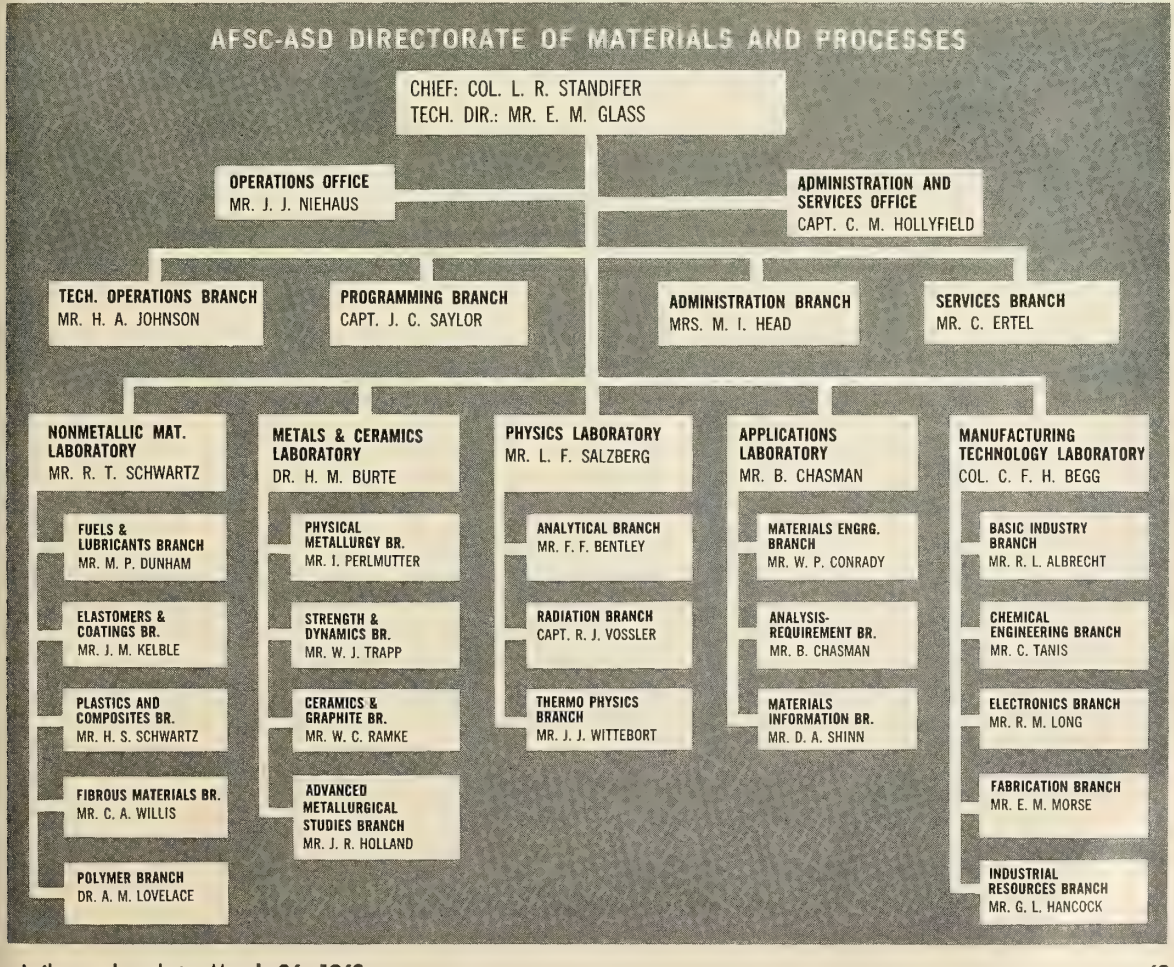
Some activity is devoted to determining the properties of metallic materials at cryogenic temperatures. This is primarily aimed at gathering enough data to permit a logical choice of structural or other materials for specific applications.

No need has yet been shown for specially developed metals and alloys in this area. Only when it is known that none of the presently available materials will suffice will any effort be expended in this direction. The major deterrent to the structural use of inorganic non-metallic materials—the ceramics and intermetallic compounds—is their low-temperature brittleness. Current materials in this category are restricted to those applications where loads are very light and fracture would not be serious.

So little is known about the applications of ceramics and intermetallic compounds that might interest the Air Force that it is difficult to give any indication as to what classes would be valuable. The same holds true in assessing their properties in terms of aerospace requirements.

The principal classes are the carbides, nitrides, beryllides and borides. Evaluation of these families include the pure forms, binary and tertiary mixtures in varying proportions. As an indication of the magnitude of this job, the Air Force estimates that the time involved for complete evaluation is 25-50 years. Cost estimations are impossible.

During the next five years, relatively few of these materials will be selected for study. Those chosen probably will have rather high melting points, and have to be fabricated through powder



ARC JET used in physics laboratory, Directorate of Materials and Processes, ASD.

metallurgy or ceramic techniques.

The effort will be concentrated on the carbides, borides, and beryllides, since available data shows these to have the greatest potential.

The technology of carbide production has been reasonably well developed, says the Air Force, and the compounds studied will most likely be those of zirconium, tantalum and titanium.

The borides will be useful in temperature environments above 3630°F, and these compounds possess the important advantage of excellent resistance to oxidation without any protective coatings. The potential is less than that of the carbides—these reach 7100°F in melting points—but coatings or some other method of oxidation protector is a necessity.

The beryllide development will proceed at a comparatively slower pace, since data on these compounds is far less extensive than that on the other two classes. These materials have a better resistance to oxidation and thermal shock than the carbides in the 3000°F range, they are also reported to have rather high vapor pressures.

This last characteristic might mean severe material loss through evaporation in certain of the Air Force's intended operational environment.

There are a host of specific requirements in advanced aerospace systems for materials with a broad range of elastomeric and compliant qualities. Applications include seals, flexible connectors, sealants, fuel containers, expulsion bladders, shock and vibration mounts and other uses.

Deleterious environments to be expected are cryogenic temperatures, aerodynamic heating, heat transfer from hot working fluids or components, contact with highly corrosive fluids and oxidizers, electromagnetic radiation, severe mechanical stresses and abrasion.

• **Disproportionate effects**—Subtle differences in environmental conditions, such as a change in working fluid formulation, may require the use of entirely different base stocks or compounding. The single most difficult area in applying the high-temperature capabilities of inorganic polymers lies in the field of elastomers. The molecular structures which result in stability at elevated temperatures are not usually elastomeric in nature.

Carbon-fluorine-nitrogen compositions may have intrinsic stability to about 600°F, but further improvements in load-bearing elastomers appear to depend on progress in compounding technology.

Factors such as purity, curing methods, additives, uniformity and special polymeric modification procedures affect the temperature capabilities of elastomers. These particular aspects, and others, will be emphasized in future Air Force research. True elastomeric materials for use up to 600°F should be available within the next five to seven years.

While elastomerics are most adaptable to sealing applications, temperature environment dictates the use of composite techniques. Improvements in the mechanical properties of seals fashioned from metallic or vitric filaments can be expected in the future. Better definitions of performance criteria should lead to more exact compounding for specific purposes. The potential in sealants will probably only be partially realized because of the effort remaining on constituents and composition problems.

Incremental gains in temperature capability, stability and reactant mechanisms will follow trends set in the solution of more immediate problems.

Fiber work extends through glass into nickel-based alloys, tungsten, molybdenum and even graphite. All of these currently lack abilities in one or more property—folding and creasing, tear strength and oxidation resistance.

These are being evaluated and investigated for use in short-term, high-temperature environment. By 1967, the Air Force expects fibrous materials to achieve a capability for short-term applications in the 2000° to 2500°F range.

These fibers will probably be refractory metals, ceramics and/or graphite. It is anticipated that users will be dissatisfied with the weight, bulk and stiffness of these materials and with the associated special handling requirements. Glass will remain the preferred material in the lower temperature regimes. Air Force experts do not expect glass fibers to operate in temperature ranges in excess of 1800°F.

One of the more restricted areas in the Air Force's materials work, in-house and contracted, concerns ablative compositions and systems. Since values change with vehicle designs and entry paths, no single heat-shield composition will take care of all applications.

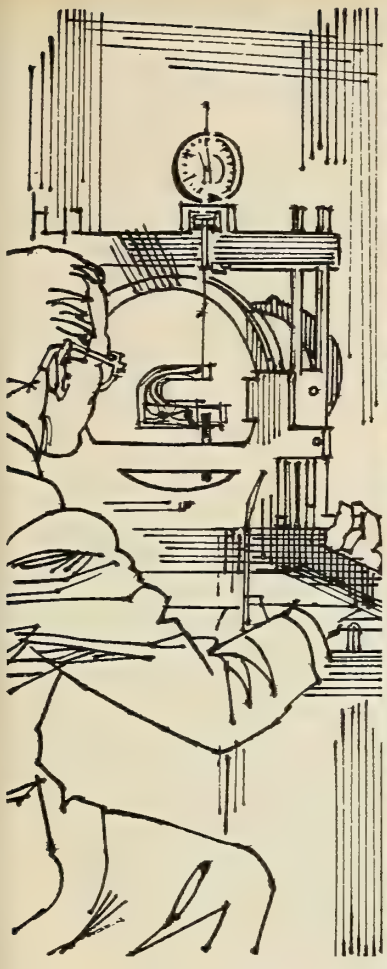
Technical problems under study include formulations for greater heat dissipation, retention of original dimensions and retension of required configuration after ablation.

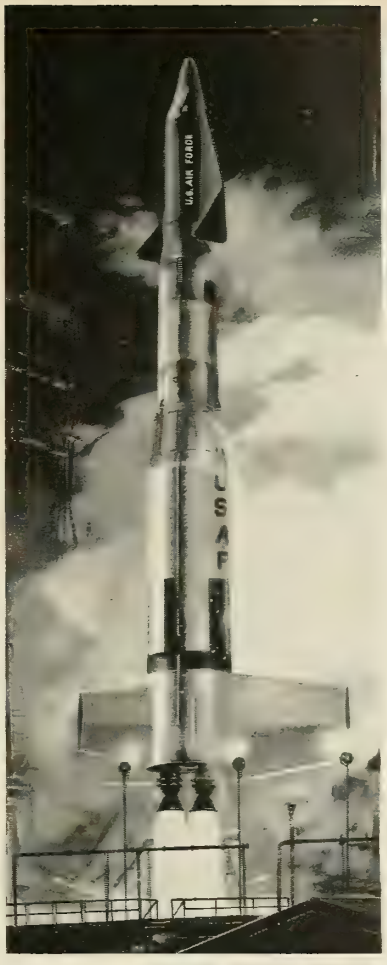
Another extremely varied field of Air Force interest is the development of structural reinforced plastics and composites. This is one area where the potential of inorganic polymers may be completely realized—in matrix formulations and adhesives. With high-temperature reinforcing materials becoming increasingly available, matrix materials remain the primary limiting factor in structural composites.

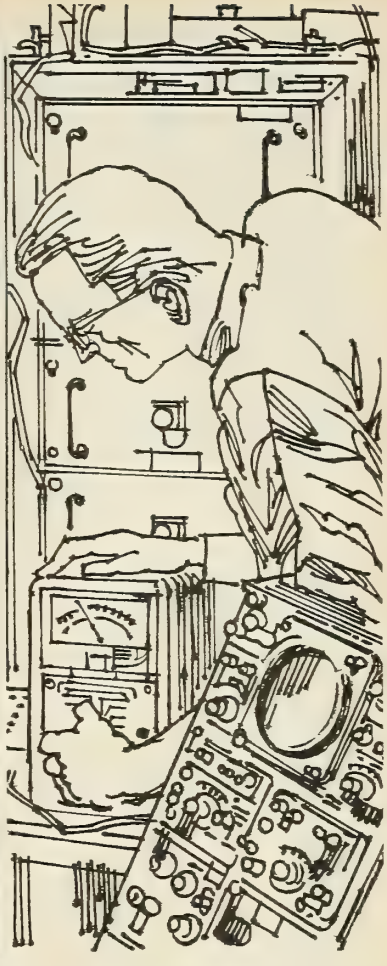
Filamentary forms of metals, metaloids, and vitrious compounds with preferred crystallinity or molecular structure appear to be the best means of obtaining high-strength, temperature-resistant, high-modulus fibers. Reinforcements with capabilities up to 2000°F should be available in five years.

It seems that binding materials lag behind the reinforcements. Inorganic polymers can probably meet a five-to-seven-year 2000°F limit for intermediate use-time periods. But beyond this, new types of matrix materials may be required. Some progress is being made with ceramic-type binders, but formidable problems exist in the mechanical properties.

(Continued on page 138)







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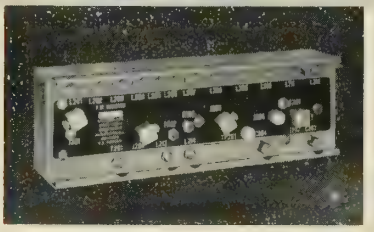

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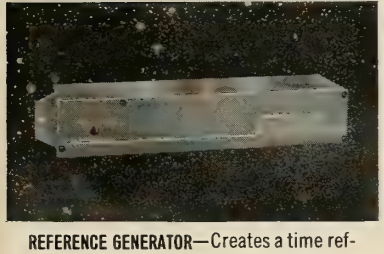
- Radio Frequency Interference measurement and reduction; components.
- "Blue Flash" Projects (field electronic technical support)
- And of course, many other classified programs.

*This classic phrase was struck by President John F. Kennedy February 20, 1962, in his remarks over television welcoming Astronaut John H. Glenn, Jr., back to Earth.



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Flight Vehicle Power Budget Climbs

Air Force carefully evaluates 1000 proposals yearly, accepts 10%; industry should be 'energy'-, not 'power-conscious'

THE AIR FORCE is expected to exceed in Fiscal Year 1963 its current multimillion-dollar budget for contracted applied research to develop concepts, components and systems for flight-vehicle power.

(Flight-vehicle power is the power needed to operate a flight vehicle, excluding propulsion but including power for electrical propulsion and for extra-terrestrial sites.)

The Aeronautical Systems Division's Flight Vehicle Power Branch (FVPB), Wright-Patterson AFB, performs and monitors all of USAF's applied research in this field.

Basic research that could lead to improved flight-vehicle-power units, sometimes called APU's (Auxiliary Power Units), is conducted and sponsored at Office of Aerospace Research facilities: Aeronautical Research Laboratory, Wright-Patterson AFB; Cambridge Research Laboratories, L. G. Hanscom Field; Office of Scientific Research, Washington, D. C.; and the European Office at Brussels, Belgium.

The APU work at Cambridge is specifically oriented to the FVPB program. (Dr. Norman Rosenberg heads up this work at Cambridge.)

When an APU project shows strong promise or potential, it is funded by Headquarters, USAF, becoming a separate line item in the Air Force budget. Once the Air Force, with the advice of the Defense Department, sets up the funding level, FVPB lets out and monitors the appropriate contracts.

Procurement of flight APU's is generally made by the weapon-system contractor.

• **The shaft is gone**—FVPB normally writes between 60 and 75 new contracts a year, and monitors between 100 and 125. The Branch evaluates a total of about 1000 proposals, solicited and unsolicited, every year. About one out of every ten unsolicited proposals is accepted.

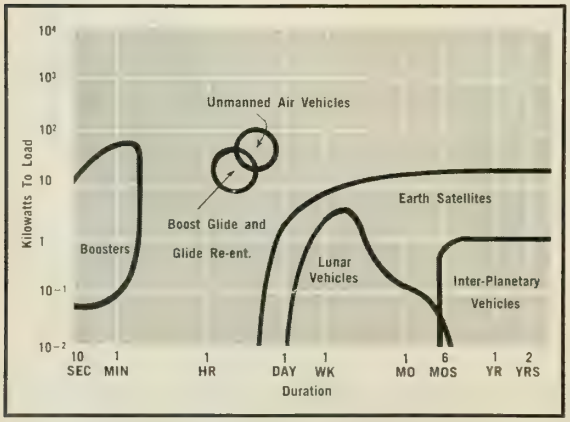
Many exploratory efforts costing less than $100,000 are backed in order to ensure the Branch against missing a potential development. FVPB also awards contracts on component and system research.

The systems getting the greatest emphasis are the 300-kw space-nuclear-system *SPUR*, and the 15-kw solar-mechanical-engine ASTEC.

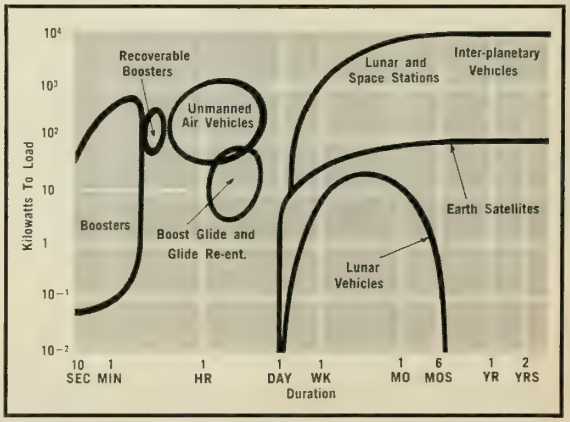
"We're vitally interested in new concepts and advanced ideas directed ultimately to power systems for advanced Air Force missions," FVPB chief George W. Sherman told MISSILES AND ROCKETS. He added, "We want unsolicited as well as solicited proposals." (Place to write is ASD (ASRMFD), Wright-Patterson AFB, Ohio.)

Sherman pointed out that the modern energy-conversion concept was born in 1949, and the Air Force has done an excellent job getting industry to think of new ways to generate power.

However, the FVPB chief complained that the program is now sagging in the "utilization" of the generated power. Equipment designers are still thinking the way they did in the days of conventional aircraft and appear to believe they have infinite power available. Sherman added, "We want industry to be energy-conscious now—not power-conscious."



Current Flight Vehicle Power Requirements



Estimated Flight Vehicle Power Requirements—1966

Sherman gave the following illustrative but admittedly far-fetched examples: instead of using the sun's direct energy—about 140 watts per square foot—a designer may consider an electric stove for cooking meals. Since we are able to convert a square foot of direct sunlight into only about 14 watts of electrical energy, the waste is significant.

"If we can now get industry to think in terms of utilization instead of only generation—using solar energy directly instead of electrical power—we will have gained a significant advance," Sherman said.

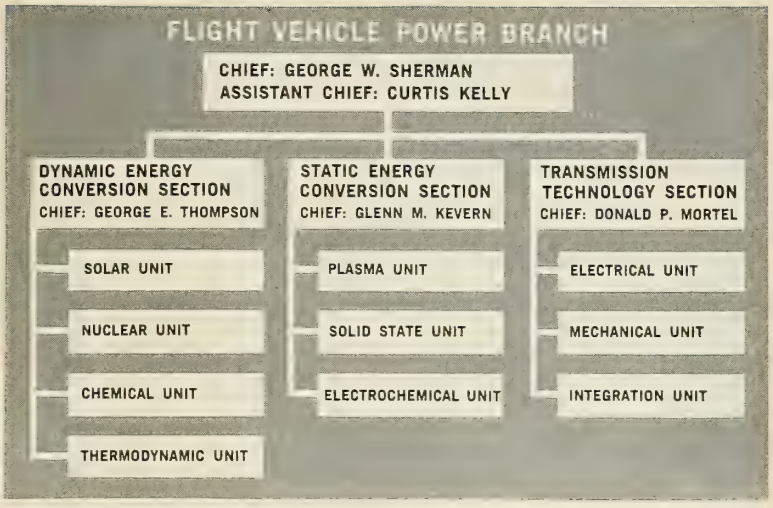
"In the ion engine," he continued, "about 30% of the electrical power required is used simply to get an ionizer, such as tungsten, hot. We have to use about 20 times more energy to heat the tungsten electrically instead of directly by the original energy or thermal source."

• **Static conversion systems** — The FVPB is staffed in three sections: Dynamic Energy Conversion, Static Energy Conversion, and Transmission Technology. Most new concepts originate or are monitored by personnel in the first two sections.

The Static Energy Conversion Section, headed by Glenn M. Kevern, monitors several small contracts in each of the following areas: solar cells, fuel cells, thermionics, thermoelectric, batteries and magnetohydrodynamics (MHD).

• **Thermionics**—Kevern sees thermionics as the most promising area in static energy conversion. He says that the method has potentially the highest efficiency and lowest weight of any other, and moreover, a thermionics system can operate at very high temperatures, which means that it can function with small radiators.

Still, there are major problem areas in the thermionics field, brought in chiefly by high-temperature operation.



There is need to find seals that will hold up under the operating temperatures—from 1100°C to 2000°C—and contain reactive materials such as cesium vapor. Unfortunately, high temperatures crack the seals, and most brazing or ceramic sealing materials are corroded by the cesium. (Cesium is used to cut down the electron charge that accumulates in the space between the cathode and anode of a thermionic diode.)

• **Fuel cells**—The chief problem with fuel cells is that of water removal, especially under zero gravity. In one design, the water goes to dilute the electrolyte; and there is a consequent need to get rid of the water, perhaps by boiling it off.

In another design the water blocks the passageways, thereby preventing the gas in the system from flowing properly.

• **Solar cells and MHD**—In conventional solar cells the problem is to reduce their production costs. A major goal is to develop "thin-film" solar cells, ones that can be attached to flexible materials—inflatable structures such as balloons—instead of to paddles.

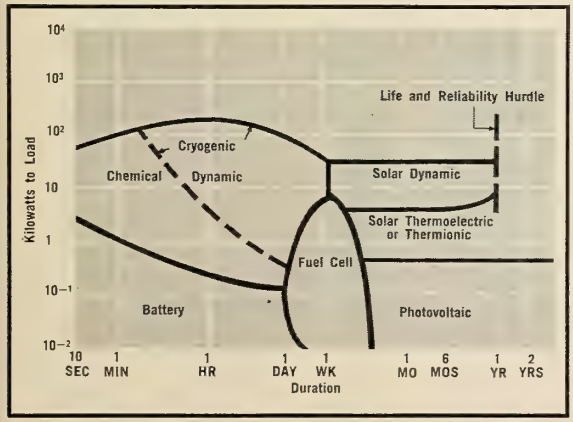
Since MHD is a relatively new area, the Static Energy Conversion Section has backed only preliminary studies.

• **Batteries**—There are two troubles with batteries, according to James E. Cooper, of the Static Energy Conversion Section: they have a relatively short cycle-life, and they weigh too much. In some instances they weigh as much as the flight vehicle.

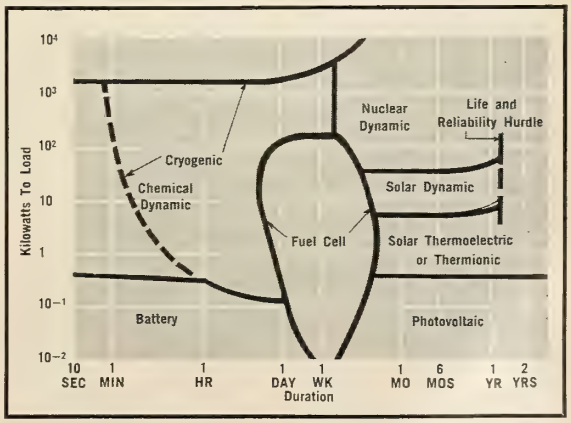
Cooper anticipates requirements for secondary batteries having as many as 25,000 to 30,000 rechargeable cycles—beyond the capability of any battery we have now.

In order to get a longer battery life, Cooper foresees an extensive evaluation and analysis program which on the one hand would determine the cycling capabilities of a number of battery couples undergoing varying environments and varying depths of discharge; and on the other hand, would correct the deficiencies of the systems as a result of the test analyses.

Cooper saw among the couples used



Energy Conversion Methods in 1962



Predicted Energy Conversion Methods—1966

High performance .....

Another proof that good things come in small packages: CEC's new, low-cost Type PR-3300 Recorder Reproducer shown on the opposite page. Equally at home in a sub, lab, or missile base, it is a solid-state instrument – matching most of the performance characteristics of larger recording devices on the market. Six standard tape speeds are provided – in pairs from 60 through 1⅞ ips – with gentle, controlled tape handling. The unique capstan drive system has the flexibility of the open loop head stack arrangement with the high performance characteristics of a closed loop. (And now see the opposite page...)

in such a program nickel-cadmium, silver-cadmium, and silver-zinc.

Cooper said that the Static Energy Conversion Section is looking into new types of couples having higher energy-weight ratios. As an example, he observed that molten-salt systems offer a potential greater than 500 watt-hours per pound.

Cooper lamented that the battery business in the past has been more or less an art rather than a science, and he indicated that the USAF program is attempting to reverse the emphasis.

He also observed that battery work offers a big area for research which could have a high payoff, but is relatively neglected because it is not as exotic as others.

• **Thermoelectric generator** — The most dramatic work in the solar-static method of energy conversion is being done in low-temperature thermoelectrics, according to George Sherman. Present effort is on flat-plate solar thermoelectric units, where the hot junction runs at about 300°C and the cold at 100°C.

(A high-temperature thermoelectric unit runs more than 1000°C on its hot side; a medium-temperature unit, between 500°C and 1000°C; and a low-temperature unit, less than 500°C.)

Advantage of the thermoelectric generator is that it costs less than solar cells and is lighter; unfortunately, conversion efficiency runs about 2% as opposed to 12% for solar cells.

The major problem with the high-temperature thermoelectric generator is that the materials involved tend to sublime away. "We could get around the problem by encapsulation, but no satisfactory method has been developed," according to Charles W. Glassburn, scientist in the Static Energy Conversion Section. 'Therefore we must go to more reasonable temperature operation."

Glassburn said that the hope is to get three to five watts per square foot out of the solar flat-plate thermoelectric generator, and up to 20 to 25 watts per pound.

(Sometime this year, the first flat-plate generator made by the U.S. is to go into a satellite payload for an orbital experiment. Plans are to make two such flights with three panels on each, typically 4-in. by 4-in. units. These will be non-concentrated, roughly-oriented devices, which could tilt as much as 30° off the sun-line and still generate 90% full power.

• **Dynamic conversion systems**— Reflecting the philosophy of the Dynamic Energy Conversion Section, George E. Thompson, its chief, also expressed the mission of FVPB when he said, "The general objective is to

raise the level of technology, not to get a specific piece of hardware to do a specific job." Continuing, he said, "Then when something is wanted, we'll have the technology in being."

• **SPUR** — Monitored by Thompson's group is the *SPUR* (space power unit reactor) program.* This power system requires a high-temperature reactor, leading to a relatively small and therefore lightweight space-radiator. Coincident with this requirement is the need for a system working-fluid (potassium) having a low vapor-pressure in order to keep the weight of the fluid containment hardware within reasonable bounds.

Potential working fluids being investigated for other dynamic systems are rubidium, lithium, potassium, sodium and cesium. However, these alkaline metals are highly corrosive, which makes the containment problem difficult. Therefore, designers must consider using refractory alloys for the tubes, such as columbium and molybdenum alloys.

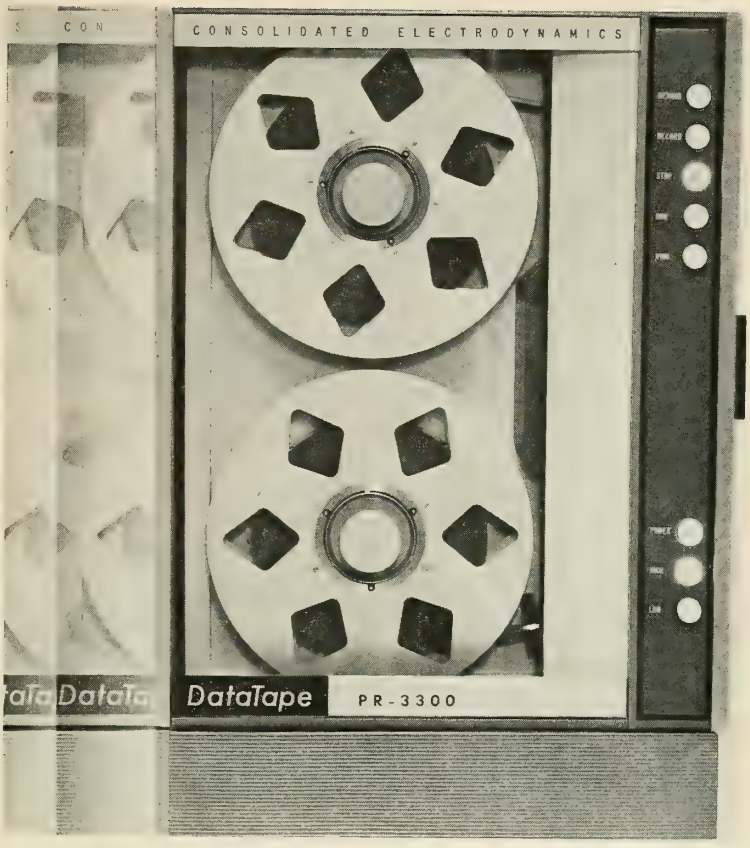
Designing with such alloys brings up problems of fabrication and joining. Additional problems are brought in by severe oxidation during ground testing at high temperatures, and the need for stringent environmental tests. In effect, the entire problem revolves about the need for temperature- and corrosion-resistant materials.

• **ASTEC**—The ASTEC project calls for a solar-mechanical system able to put out 15-kw. Operating under a Rankine cycle and being investigated by Sundstrand Aviation, Denver, Colo., ASTEC is expected to provide the technology for high-temperature power devices in the 10 to 25-kw regime, and also the techniques which will yield relatively higher efficiencies and performance.

Aim of ASTEC is to get system weight down below 70 lb./kw and cycle efficiency up to 24%. Two energy storage materials will be used, lithium hydride and sodium fluoride. The working fluid will be rubidium which will undergo two expansions in a high-temperature turbine and a low-temperature turbine.

(The high turbine-inlet temperature of 1750°F with a radiator temperature of 675°F is described as potentially yielding a lightweight system, provided

**The SPUR program is being conducted by AiResearch Manufacturing Co., Phoenix, Ariz., with Aerojet-General Nucleonics, San Ramon, Calif., providing the reactor work. The Atomic Energy Commission is working with the Air Force to guide the reactor investigations.*



.....and portable

In addition to high performance (see opposite page), the PR-3300 features portability: a single 22⅝" case houses a complete 14-channel record and reproduce transport. Removed from its case, the unit can be mounted vertically in most standard racks. It's a package well worth looking into: a recorder reproducer outstanding in its class. For full facts, call your nearby CEC office or write for Bulletin CEC 3300-X4.

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that the serious materials problems for the thermal-storage unit can be solved and a lightweight solar collector developed. This system will require a collector diameter of about 45 feet.)

• **Cryhocycle** — Sundstrand Aviation's Cryhocycle power-generating system concept is perhaps the ultimate one for short-duration space vehicles. Reason given is that power is taken from waste heat and moreover the turbine is operated at 300°F, thereby ensuring high reliability and relatively long life.

(The Cryhocycle is a concept calling for full integration of the power-generation equipment with the thermal control. Although the concept is described quite favorably, Thompson points out that the power-system designer must also be an exceptionally good systems integrator.)

• **Cryogenics** — Future programs will still pose a requirement for power in the 25 to 100 horsepower regime.

One way to get it is through open-cycle power-generation system concept Kidde & Company is working on a hydrogen-oxygen system that is expected to yield between 24 and 40 horsepower for 36 hours' continuous operation.

(Hydrogen fuel burned in a combustion chamber forms vapor which turns a turbine-alternator combination.)

Biggest problem in this cryogenic-type APU is storing and pumping the cryogenic elements—particularly onerous in a weightless environment.

To help alleviate the pump problem, Thompson said that his Unit is going into a very low-flow, high-pressure, liquid-hydrogen-pump program.

(Most cryogenic pumps are built for rocket-engine installation, needing very high flow rates, far beyond those needed for a small horsepower unit.)

Thompson spoke of a Vickers Inc. effort aimed toward use of hydrogen and oxygen in a four-stroke engine. If it works, Thompson foresees the possibility of getting the specific fuel consumption down to 0.75 lb./hp-hr.

• **Binary cycle**—Thompson's Section is also starting a preliminary investigation of the problems of a relatively low-temperature binary Rankine cycle. Thompson Ramo Wooldridge Inc. in Cleveland is doing the work. The company is looking into getting a low-temperature cycle fluid to mate with mercury, which is the high-temperature fluid. Also to be pursued are integrating the collector and radiator, and devising a two-fluid seal which is needed if the turbines of both cycles are to be mounted on the shaft. Using this binary technique is one way to get major advances in performance without having to crack the very-high-temperature materials problem. ⌗

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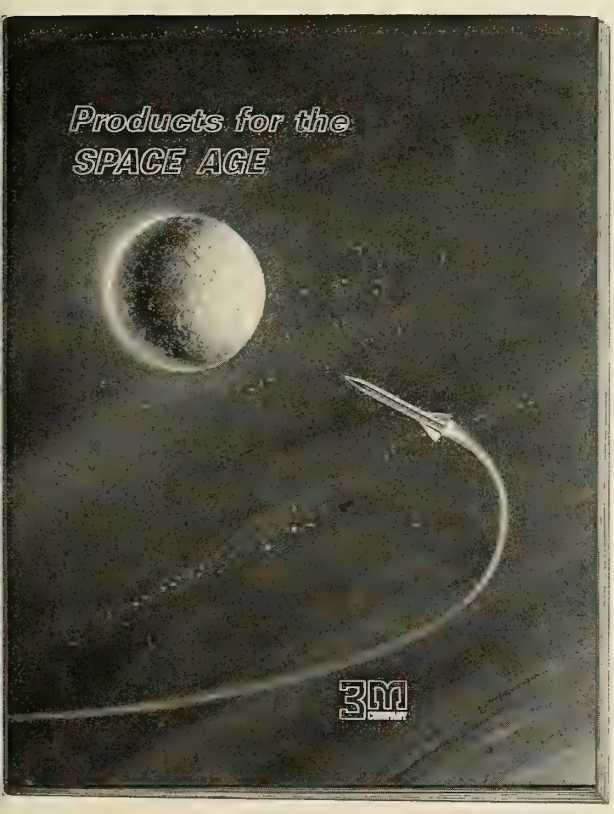

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AF Experience Points to Growing Role

Service feels it can easily support both civilian and military programs; a look at some of the major objectives

HOW DO YOU stop a runny nose in zero g? Or does a nose run at all? How much food should a weightless man eat? Will our astronauts come back fatties, or too thin and emaciated to withstand the heat and vibrations of re-entry?

These are but a few of the host of questions the Air Force seeks to answer in the next few years. For in spite of attempts by other organizations to downgrade its role, it figures to play an increasingly important part in bioastronautics field.

The Air Force has a hard core of capable administrators, laboratory men and technicians in the space medicine field. Almost anyone versed in the field owes his knowledge in part to the Air Force—to its facilities, its men or its financial support.

The service will continue to make a strong bid for the task of bioastronautics support of civilian programs. As one AF official put it, "We are in a good position to support any of the nation's space programs without increasing our resources to any great degree or even affecting our own programs. After all, whatever is done in the Air Force is overdesign for civilian programs."

The elevation last fall of the Air Force's bioastronautics into a separate command division indicates the growing stature of the program. The Aerospace Medical Division of the AF Systems Command now includes the School of Aerospace Medicine at Brooks AFB, the Aerospace Medical Research Laboratories at Wright-Patterson AFB, the Aeromedical Laboratory, Holloman AFB, the Personnel Research Laboratory and Air Force Hospital at Lackland AFB, and the Arctic Aeromedical Laboratory at Fort Wainwright.

A ballpark figure for the AF bioastronautics budget is hard to find. Although some Congressional testimony has indicated it may be around $12 million, it's probably a great deal higher when flight programs, construction, salaries and basic research funded under the Office of Aerospace Research are figured in.

• **Orbiting labs**—The first step most AF bioastronautics planners would like to take is the orbiting of a carefully planned animal laboratory. Several such proposals have been on the books for some time, such as the *Discoverer* monkey capsule and the *Biological Orbiting Space System (BOSS)* (M/R, April 24, 1961, p. 17). Lack of priority has prevented getting these programs off the ground. It's a good bet, however, that something concrete will appear within

Navy Contributes Greatly to Bioastronautics

WHILE THE Air Force and NASA debate who should do the nation's bioastronautics work, the Navy has been quietly continuing its work in the field.

The Navy's input into the space medicine world, although not comparable in size to that of either of the other agencies, has been an important one.

The Navy centrifuge at Johnsville, Pa., has played a significant role in the *X-15* and *Mercury* programs. All the *Mercury* astronauts received acceleration training and performed flight profiles on the device. And more than 50 potentially fatal situations involving the *X-15* aircraft were detected there. Auxiliary studies at the lab include evaluation of performance under stress, biochemical stress indicators, instrumentation and equipment design.

The Air Crew Equipment Laboratory (ACEL) at Philadelphia has participated in the development of much of the military's air crew equipment, and the *Mercury* spacesuit. Some high-altitude and other stress tests for *Mercury* were conducted there also. This laboratory is certain to have a role in the development of flight-prototype equipment for space, including regenerative water and oxygen devices.

• **Nautical Sam**—The School of Aviation Medicine at Pensacola has been a leader in the space business since it collaborated with the Huntsville Army group on the first ballistic animal flight and recovery. The famous monkey Baker, in fact, made her permanent home at Pensacola.

The Naval School's staff boasts such research luminaries as Capt. Ashton Graybiel, Dr. Herman J. Schaefer and Dr. E. E. Beischer, Dr. Graybiel, also research program director of the School, is known for his outstanding contributions on disorientation in slowly rotating environments.

Part of Dr. Graybiel's work is funded by NASA. U.S. space medics are particularly interested in "Titov's sickness," and Pensacola is making basic studies of the mechanisms of the inner ear to see which organs may cause sickness under certain stresses.

Experiments are made both with animals and humans. Dr. Graybiel told M/R that by studying monkeys who have had different parts of their inner ears surgically removed, his group could learn much about what causes motion sickness. Monkeys, he said, are susceptible to many of the same types of motion sickness as man.

A few human subjects who have suffered accidents in which parts of their inner ears were damaged have been utilized in research also.

If the researchers can find out exactly what causes the sickness, sweat-

a year.

• **Weightlessness** — The only new tool the Air Force really wants with which to study weightlessness is the orbital laboratory. Some fine work has been done in researching aspects of weightlessness, such as water simulation, but the core of the problem has not been touched.

Zero-g studies are being performed both at the School of Aerospace Medicine at Brooks AFB, and at the Aerospace Medical Research Laboratory at Wright-Pat. Brooks has confined its work to the partial immersion of its subjects, leaving their heads above water and retaining communication with them.

At Dayton, AMRL has studied the confinement and isolation aspects of water immersion as well as the physiological aspects. And brief moments of true weightlessness have been experienced in the laboratory's C-131B plane.

Spokesmen for the laboratory say that research will soon begin on methods of propelling man in a zero-g environment, with particular emphasis on whether or not he need be tethered to a life line. The frictionless platform at the lab is a good tool for this project.

AMRL people wish to continue their studies of the physiological, debilatative aspects of long-term weightlessness. Presumably they will have to be limited to the water tank approach.

Probably the prime contractor requisite in support of this research will be in the field of bioinstrumentation improvement and design. New instruments will be needed, such as a method of measuring calcium excretion and other significant parameters.

• **Radiation**—The Special Weapons Center at Kirtland AFB recently designed a tool for measuring radiation which promises to add a great deal to our knowledge of its potential effects on man.

SWC designed a plastic which simulates the human skin in its absorption properties and behavior under irradiaton. Packages of this plastic have been flown in the *X-15*, on missile shots and *Discoverer* vehicles.

The Special Weapons Center is interested in radiation protection by virtue of its nuclear weapons effects studies.

Laboratory studies have been conducted by the School of Aerospace Medicine. The School has designed high-altitude balloon flights and rocket flight packages of biological radiation counters.

• **Psychology** — Isolation and confinement studies have been performed in the water tank by the Behavorial Sciences group at Wright-Pat. Other tests have been made with groups up to five men, who were isolated in the anechoic chamber. SAM has made several 17-day and 30-day tests in their two-man simulator.

A subject of great interest to AF psychologists is the ability of its pilots to perform under stress.

• **Biomedical instrumentation** — A real field for industry work is in the improvement of sensors—the attachments which convey the workings of the body to electronic data.

Especially needed is a blood pressure sensor which does not impinge upon the wearer's performance. An Air Force space medicine expert said that a method of taking a good electroencephalogram is desired.

The Air Force badly needs the development of a simplified method of readout of the tremendous amounts of physiological data which can and needs to be secured from its astronauts.

• **Medical practice**—Within the next few years, the challenge of a new era of medical practice must be faced by the earth-bound medical profession.

Diagnostic techniques and treatment methods for weightless condition must be developed. For instance, what is a normal temperature and blood pressure?

How can medical men give a blood transfusion or an intravenous drip in space? A whole new world of medicine must be developed.

Sensing and diagnostic abilities which can be used in pre-launch screening must be found. For example: which of two healthy men will develop a cold next week? Which may get an upset stomach? Some of these questions may be assessed on the ground. Most must wait for an orbital laboratory.

• **Accelerations** — A protective device for impact accelerations in the 40-60-g regions would be an object of prime interest to the Air Force now. Later, say officials, there may be requirements for a protective garment or device for impact accelerations up to 100 g. The feasibility of such accelerations is being studied at Holloman AFB.

The Wright-Pat Lab will get an excellent research tool for accelerations when the dynamic escape simulator designed and constructed by the Franklin Institute of Philadelphia is finished.

The facility, which cost $1.7 million,

ing and visual aberrations associated with disorientation, they may be able to find drugs or other methods of compensating for it.

• **Gear required**—Some of the equipment the Navy may be looking for in the next few years includes better equipment for recording nystagmus (movements of the eyes indicating motion sickness). And, like the Air Force, the Navy desires better integrators for its instrumentation and a better readout method.

Studying the mechanisms of the nausea syndrome may call for some instrumentation — such as lightweight X-ray equipment for studying the gastro-intestinal tract. Navy spokesmen also foresee the need for all the equipment incidental to measurement of cardiac output under stress.

Biochemical equipment for analyzing the "cold sweat" of motion sickness and adrenalin output eventually will be needed.

According to Dr. Graybiel, the study of combined stresses is very important, but there is a lot of basic research to "knock off" first.

A new 20-ft. dia. rotating room will be installed at the School for the disorientation studies. Mild heat and cold stresses will be simulated together with rotation in the new chamber.

Dr. Schaefer designed the small nuclear emulsion pack to measure cosmic radiation impact in Project *Mercury*. Currently, he is taking emulsion pack results from *Pioneer* shots to determine what ionizing radiations they have recorded.

Dr. Beischer is a leading expert on biological effects of magnetic fields in space travel, and has lectured and written papers on the subject.

• **Other efforts**—NASA supports several projects at Pensacola, one of them on the effect of magnetic fields on man and animals. The effect of high Gaussian fields on animals and the effect of low and zero Gaussian fields on man are getting special attention.

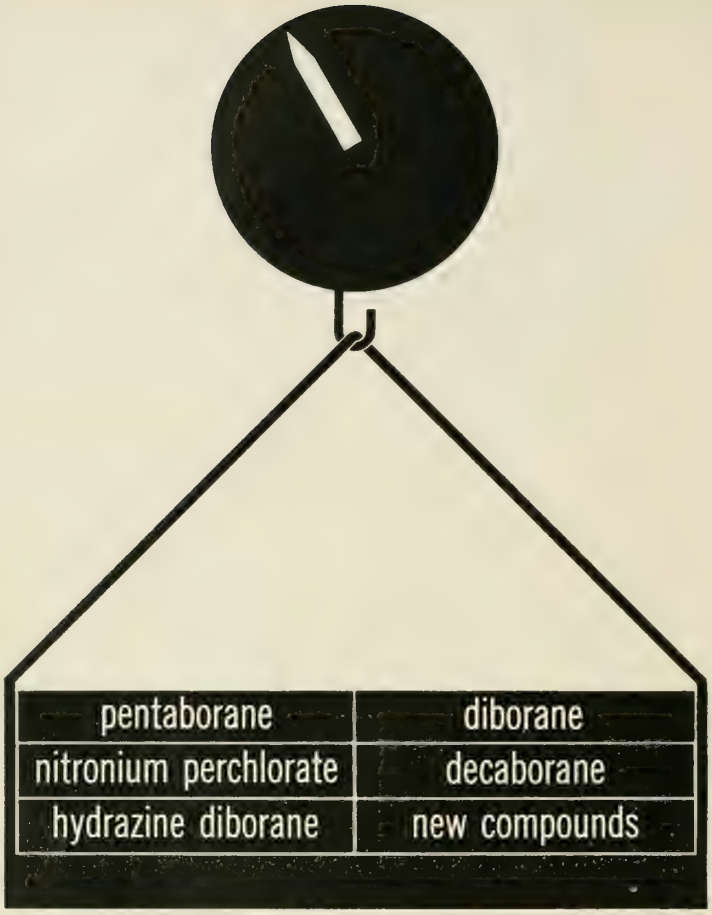
Another NASA-supported project deals with the development of a ballistocardiograph for zero g.

The Navy's psychology department is continuing its contributions in techniques for selecting astronauts.

Other Navy centers doing space-applicable work include the Medical Research Laboratory at New London, Conn. This center studies closed environments in conjunction with its submarine support work.

In addition, the Naval Medical Research Institute at Bethesda, Md., carries out some basic research which is relevant to space.

At Point Mugu, Calif., the Naval Missile Center's Life Sciences Department supports space medical studies at the Pacific Missile Range. ⌗



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will phase out the present centrifuge in the biophysics building at ASD. Researchers will study the effects of complex acceleration patterns on pilots and astronauts, including those encountered in capsule escape.

The simulator, which will be operational early next year, will be capable of applying forces up to 20 g at rapid onset. It also will tumble about two additional axes, with speeds up to 30 and 150 rpm, respectively.

Also to be delivered this year is a capsule which will combine acceleration, heat and pressure stresses, and one which will enable the simulation of low-frequency, high-noise conditions.

Vibration problems have become increasingly important with the development of larger rocket boosters. A five-month test was just completed at the Atlantic Missile Range to measure the sound levels produced during present-day launch operations at Cape Canaveral. Air Force researchers are trying to estimate the hazardous effects of noise environments from *Nova* and larger rockets upon antennas and other equipment. It states that such estimates are urgently needed to assist planners in locating launch sites and facilities. Bioacoustic data on man's reaction to low-frequency noise are also definitely needed.

Re-entry of lunar or space vehicles is a concern to bioacoustics experts. Several pieces of equipment at the Aerospace Medical Research Laboratory have been used to establish tolerance criteria. These include two vibration tables and the vertical accelerator.

Restraint devices for the buffeting vibrations of re-entry are of interest.

A problem which goes hand-in-hand with the hazards of large booster noise is the problem of intercommunications. The Air Force spokesmen say present systems have a long way to go in reliability, fidelity, clarity and comfort if they are to be adapted to future systems.

A move to contract for a better system of audio-communications between vehicle and ground or control stations can be expected imminently.

• **Thermal problems**—Man's tolerance to thermal stress has pretty well been defined, largely by the work of the Aerospace Medical Research Laboratory. The lab has several heat chambers, one of which can also simulate the dark-light sides of a space capsule. One wall may be heated to represent the side of a capsule in direct sunlight, the other the dark exposure to space.

The problem becomes one of protection. The Air Force is looking for two things: First it seeks materials which have a high heat reflectivity which can be used in protective garments. It also is looking for a new method of ventilating suits other than by carrying

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• **Life support engineering** — The Air Force has very plainly stated that it wishes to put its men in their ideal environment—just like that on earth. It further says that it is up to the engineers to make leak-proof systems or develop sealants for repairing spacecraft, so that a normal atmospheric pressure and gas mixture can be easily maintained.

There has been evidence that exposure to 100% oxygen for long periods of time damages the lungs. However, more research along these lines may be needed, since ideal leak-proof systems may not be available in the near future.

Regenerative electro-chemical or electro-physical (solid-state electrolysis) systems will be of interest to the Air Force. At present, planners wish to do without stored chemical systems and seek something they feel is simpler.

Flight-perfect means of measuring gas quantities are needed. The Air Force leans to the gas chromatography approach eschewing the solutions needed for mass spectrometry.

Both AMRL and SAM will use prototypes of water recovery systems and oxygen recovery systems for study under simulated space conditions.

The School of Aerospace Medicine's physiology-biophysics branch also is interested in means of utilizing the excess water produced by the human body in a recycling process. In other words, the body gives off about 10% more water in respiration and waste than it consumes. This water comes partly from the oxidation of some of the solid food consumed. One suggested means of disposing of this water is by cycling it into aquaeous life support systems such as photosynthetic gas exchangers or hydroponic systems.

Toxicology is a concern of both AMRL and SAM. The advent of new boosters presents a special challenge. Some in-house research is being conducted—such as the School's novel approach with a calorimeter—but AF sources say they may be interested in turning over some of this problem to industrial laboratories and universities.

• **Systems research**—As each new space vehicle and missile or rocket system is designed, human engineering techniques must be developed along with it.

The tremendous amounts of information which must be handled by the launch crew creates a climate for errors. Ways of presenting this information in the best and simplest manner are needed.

Better methods of presenting in-flight information and design of controls remains a field in which work can always be done. Psychologists' studies on how adequately and how clearly the information must be presented for the human to respond correctly also must continue.

These aspects are largely handled by the Aerospace Medical Research Laboratory, working closely with Aeronautical Systems Division of the Air Force Systems Command.

• **Selection of astronauts**—It's unlikely that the U.S. will deviate from its policy of choosing the highest physical and mental specimens for astronauts. However, some refinements may be made.

As our knowledge of space conditions increases, it may require the adjustment of some standards. For instance, some researchers suspect that far-sighted men may perform better in space than those with normal vision. Development of exact criteria must be done jointly by physiologists, psychologists and physicians.

• **Nutrition** — Dietary experts at Wright-Pat have already done much of the ground work on how to prepare and feed man during weightlessness. Until flights of long duration are near, little more needs to be done.

The problem remaining relatively untouched is one concerning the caloric needs of man. Weightlessness may have a profound effect on what kind of a diet spacemen will require. On the other hand, the fact that the orbiting spaceman will eventually have to face reentry may mean that he must "stuff" himself to keep up his strength. This can only be determined by using an orbital animal laboratory.

• **Drugs**—If it is determined that drugs may be needed to maintain a normal existence in space (to make it possible to sleep, for example) the Air Force must be assured that the side effects are not worse than the malady. Most such decisions will wait until an orbiting laboratory helps determine what may be needed.

• **Hypnosis**—The Air Force is not actively pursuing hypnosis or hibernation as an immediate problem, although some researchers feel that either may have application in about 10 years. The Office of Aerospace Research, does, however, endorse basic research in this field.

A big problem limiting the growth of the aerospace bioastronautics effort is the lack of qualified people on all levels. As one AF expert put it "We need physiology majors who understand engineering disciplines and systems development—and vice versa.

"Until we get more qualified people, there's not much point in putting in a great deal more money." ⁂

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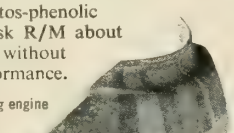

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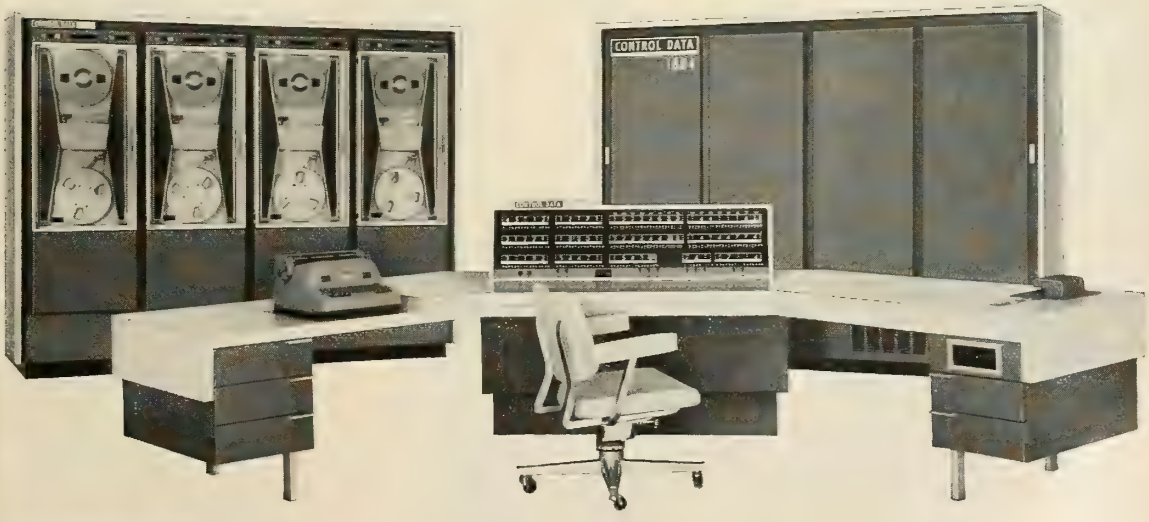

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Services Propose–DOD Disposes

Department leadership maintains that technology needs much more development before military role is enlarged

DR. HAROLD BROWN—*R&D Director. His office holds the pursestrings.*

JOHN RUBEL—*Assistant Secretary. Acts for Department on space matters.*

JACK P. RUINA—*ARPA head. Agency links basic research with weapons.*

"He who chases after two rabbits catches neither."

THIS JAPANESE proverb—quoted by Assistant Secretary of Defense for Research and Engineering John H. Rubel in an interview with M/R—is probably the best synthesis of DOD's opposition thus far to an expanded military role in space.

In the thinking of Defense Department officials, the military services would do well to concentrate on results from projects in being before making demands for more resources.

Two cost over-runs in the *Advent* communications program, and similar delays and procrastinations in the *Satellite Interceptor* program, were cited by one Defense official as proof of the lack of solid achievement in the military space program.

Rubel and other DDR&E officials, however, are not suggesting that the second "rabbit" be neglected.

Rather, they are pressing for what they consider an orderly development of technology so that, when a military mission for man in space does materialize, the technology to support this mission effectively will exist.

"We are a long way from that point now," Rubel asserts.

Consequently, DOD planners insist that the military space budget will grow steadily over the next four to five years, but will nowhere approach the explosive growth of the NASA budget. Far more likely, in the opinion of DDR&E planners, will be incremental increases—such as the $300 million Military Astronautics boost in the FY '63 R&D budget.

• **DDR&E power increased** — In the same directive assigning the Air Force the responsibility for "research, development, test and engineering of Department of Defense space development programs or projects," the power and control of the Director of Defense Research & Engineering was substantially increased.

According to the March 6, 1961, directive, each military service is free to conduct "preliminary research" on space projects which might be helpful to it in accomplishing its assigned missions. However, DDR&E is given the power to determine the scope of such research "in terms of expenditure limitations and other appropriate conditions."

The authority of the Director of Research and Engineering was also ex-

tended to R&D proposals from the military services for space programs and projects. Specifically, the McNamara edict directed that these proposals "be submitted to the Director of Defense Research and Engineering for review and determination as to whether such proposals, when transmitted to the Secretary of Defense, will be recommended for approval."

Thus, without the imprimatur of DDR&E, the military services have almost no chance to develop duplicating or marginal space systems.

• **DDR&E organization** — Actual overall management of DOD space program is vested in the Assistant Secretary, John Rubel. Both Secretary of Defense Robert S. McNamara and R&E Director Dr. Harold Brown have delegated to Rubel the authority to act for DOD on space matters.

It is Rubel who determines the resources of the Defense Department to be expended on space programs and exactly what these programs will be. Working with his NASA counterpart, Dr. Robert C. Seamans, Jr., he also is responsible for working out agreements defining the extent of NASA-DOD cooperation. At present, the extent of AF participation in the Manned Lunar Landing program is being defined by the two agencies.

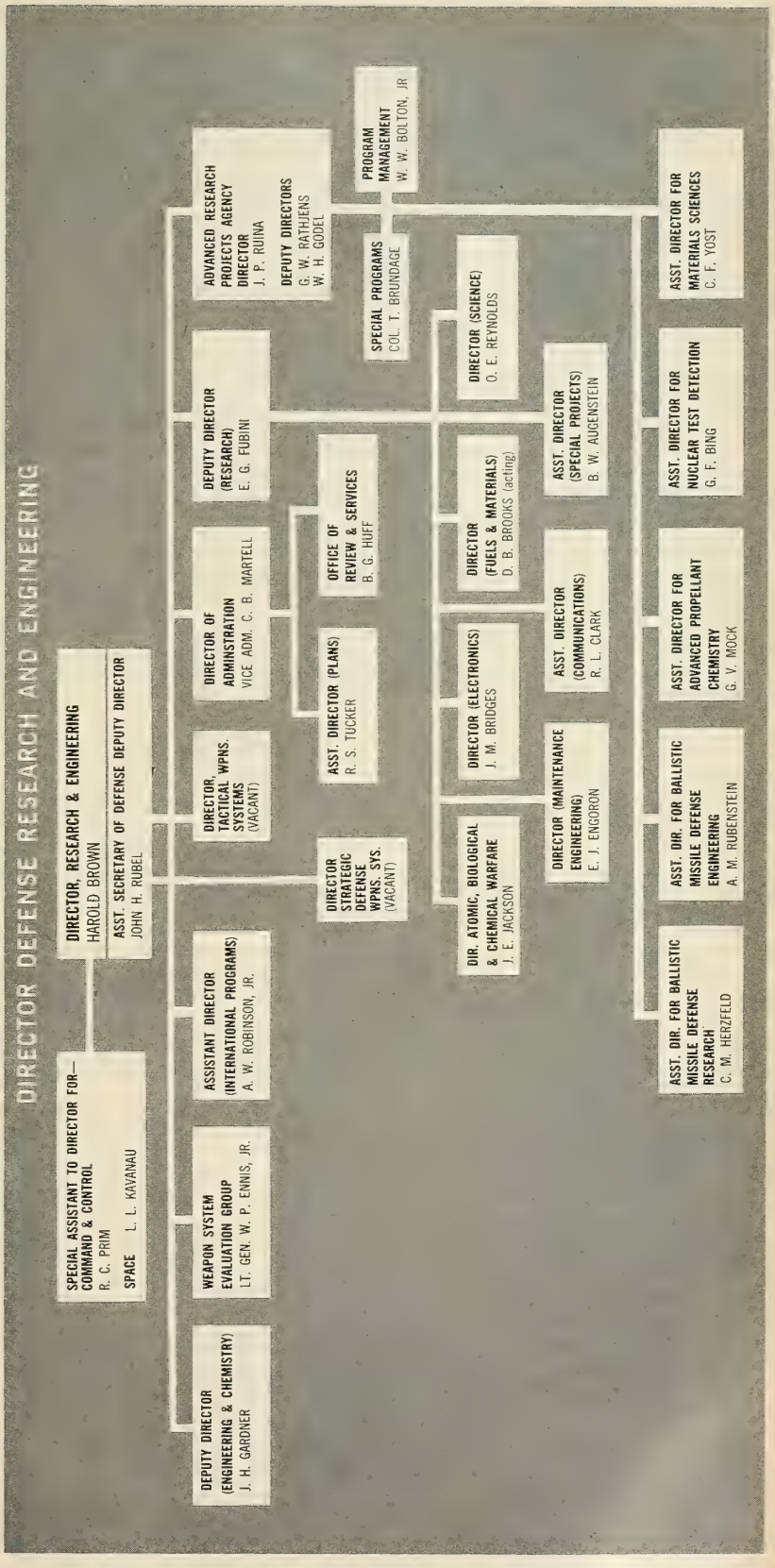
In order to fulfill these tasks, Rubel can and does call on the not inconsiderable resources of the DDR&E organization. Within the office of the Director itself, there is a Special Assistant for Space who reports to both Dr. Brown and Rubel—Dr. L. L. Kavanau.

This office is the focal point for the DOD problems in the space area. As such, it monitors only selected programs—such as *Titan III* and *Centaur* —but receives progress reports on other space programs. The main function of this office is an attempt to keep in focus the broad problems of space technology and to conduct such other investigations as required.

Specific space programs are monitored by the directorates within DDR&E which have cognizance over the general area of technology applicable to the space system. For example, the Assistant Director for Air Defense is responsible for overseeing the *Satellite Inspector* program; Asst. Director for Communications, the *Advent* program; and the Director of Electronics, *Transit*.

• **DDR&E-industry relations** — Since DDR&E is charged with the overall direction of the military space program, it is less interested in specific technical proposals than in promising developments that a company may be working on.

As one DDR&E official explained it, "Contractors are less likely to sell a



Major ARPA Fields of Interest

Advanced Ballistic Missile Defense—Project Defender

Research under this program is oriented toward exploration of fundamental phenomena, the interpretation and analysis of experimental data, formulation of new systems concepts and the application of new techniques for advanced defense against ballistic missiles and other long-range offensive weapons.

Ballistic Missile Penetrations Aids Program

ARPA initiates or monitors any needed research related to the vulnerability and re-entry of ballistic missile systems. Implicit in this program is insuring that other DOD organizations have the required data concerning re-entry vulnerability and observables for studies of missile effectiveness.

Nuclear Test Detection—Project Vela

Project consists of programs of research, experimentation and systems development for improving the detection of nuclear explosions both underground and at high altitude. It is subdivided into three major programs:

Vela-Uniform—*directed to improving in seismological and other geophysical techniques for detecting underground nuclear tests.*

Vela-Sierra—*concerned with research on and development of techniques for the detection and identification of high-altitude detonations by means of equipment on the surface of the earth.*

Vela-Hotel—*involves the development of surveillance equipment which would be installed on space vehicles for detecting nuclear detonations above the sensible atmosphere. Included are detector development, background measurement, the investigation of detector behavior in the natural radiation environment in space and experimental satellite flight testing.*

Basic Research in Materials—Project Pontus

Research, experimentation and development to obtain major improvement in materials required to meet the needs of surface, air or missile programs. Programs include metallurgy, ceramics, solid-state physics, inorganic chemistry, polymer science and phenomenological studies of materials behavior.

Advanced Propellant Chemistry—Project Principia

Research leading to solid, liquid and hybrid propellants having specific impulses appreciably higher than those now available. Research includes thermodynamics, thermochemistry, synthetic chemistry and propellant formulation and evaluation.

Advanced Energy Conversion—Project Lorraine

Research in the fundamental aspects of energy conversion in the following categories: thermionics, thermoelectrics, electrochemistry, magnetohydrodynamics and ancillary studies.

Command and Control Research

Continuing research program investigating techniques for modeling command systems (both within single commands and between interacting commands), analysis and specification of information flow and processing needs, determination of the most effective man-machine relationships and command structures, studies of areas amendable to standardization and of methods of control of command support systems by commanders.

Cloud Physics—Project Baton

Fundamental characteristics of cloud physics, how clouds are formed, perform and dissipate are being investigated—particularly with respect to defense needs.

Field Conflict Technique

Project designed to improve the combat capability of indigenous troops engaged in counter-guerrilla warfare in underdeveloped areas.

Technical Aspects of Arms Control—Project ARA

Study program on the technical areas of arms control measures, including both short-range and long-range aspects. Short-range studies will support current or planned negotiations and undertake to investigate areas of immediate concern as authorized. Long-range studies will explore the subject broadly, develop new points of view and define alternative lines for future negotiation.

Behavioral Sciences

Research in the fields of human performance and persuasion and motivation—including work on the process of persuasion, rationality in decision-making, the relationship of attitudes to behavior, group relations, communication and the relation of cultural differences to persuasion.

product here, but it is certainly in their interest to keep us educated on promising developments."

• **ARPA's role defined**—After several years of changing missions, the Advanced Research Projects Agency (ARPA) has finally come to rest in the Office of the Director of Defense Research and Engineering.

Headed by Jack P. Ruina, ARPA is, in effect, the bridge between basic research and the development of specific weapon systems as illustrated by the scope of their work shown in the box above.

Project *Defender*—ARPA's major effort in terms of money ($110 million in FY '63)—is designed to investigate concepts for "future systems of defense against ballistic missiles." Project *Vela* is another major area of ARPA involvement.

• **Contractor procedures**—As illustrated by the box showing ARPA programs, the Agency is interested in almost all areas of technology—ranging from sensors and radars for Project *Defender* to studies in the behavioral sciences.

As a consequence, ARPA is interested in talking to anyone in industry with a worthwhile proposal. (Much of ARPA's time, according to one scientist, is spent "knocking down bad ideas.")

For this reason, the brochure outlining ARPA procedures on the preparation and submission of unsolicited proposals warns that "the proponent should make a thorough search of all technical reports, patents and other data pertaining to the subject in order to become thoroughly familiar with the state of the art."

Proposals—normally not to exceed 25 pages in length—should be submitted to the Director, Advanced Research Projects Agency, The Pentagon, Washington 25, D. C.

Information required in these proposals includes:

—General statement requesting consideration of the proposal.

—Proposal signed by the principal investigator, the department head and an official capable of committing the organization in business and financial matters.

—Technical description of the proposed work and of work previously done in the field of the proposal.

—Statement of the project objectives and identification of problem areas and results expected.

—Technical approaches proposed.

—Special facilities and equipment required and available.

—Major phases and action milestones expected.

—Estimate cost of the proposal, showing a breakdown of major cost categories.

—Names and background of principal scientists and engineers to be used in the project—as well as other government work under contract by the group.

In addition proprietary as well as patent data should be identified.

Since contracting for most ARPA work is generally accomplished by the three military services, the Agency recommends that contractors obtain copies of the individual services' R&D contracting procedures. ⌗

Today, the design and development of space systems, vehicles and weapon systems is achieving an even greater degree of importance than before. Expenditures are increasing. The pace is being stepped up.

Hughes Aerospace Divisions are expanding with each of these progressions. Important projects such as SURVEYOR, SYNCOM, ION ENGINE, ARPAT, BAMBI and advanced POLARIS guidance are now underway. Others will begin soon. This expansion is producing new, challenging assignments that never existed before. The opportunity is for you. You can be a part of, and benefit from, Hughes further expansion into the space picture.

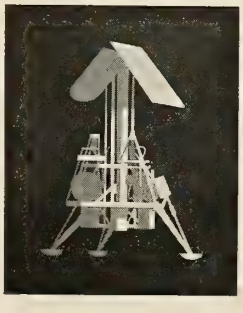
If you hold a degree from an accredited university in Mechanical Engineering, Electronic Engineering or Physics, are a U. S. citizen and have experience or interests related to Aerospace Vehicles or Weapon Systems, you can qualify. A few of the openings include:

controls engineers
Concerns airborne computers and other controls related areas for: missiles and space vehicles, satellites, radar tracking, control circuitry, controls systems, control techniques, transistorized equalization networks and control servomechanisms.

circuit designers
Involves analysis and synthesis of systems for: telemetering and command circuits for space vehicles, high efficiency power supplies for airborne and space electronic systems, space command, space television, guidance and control systems, and many others.

systems analysts
To consider such basic problems as the requirements of manned space flight; automatic target recognition requirements for unmanned satellites or high speed strike reconnaissance systems; IR systems requirements for ballistic missile defense.

infrared specialists
To perform systems analysis and preliminary design in infrared activities involving satellite detection and identification, air-to-air missiles, AICBM, infrared range measurement, air-to-air detection search sets, optical systems, detection cryogenics and others.



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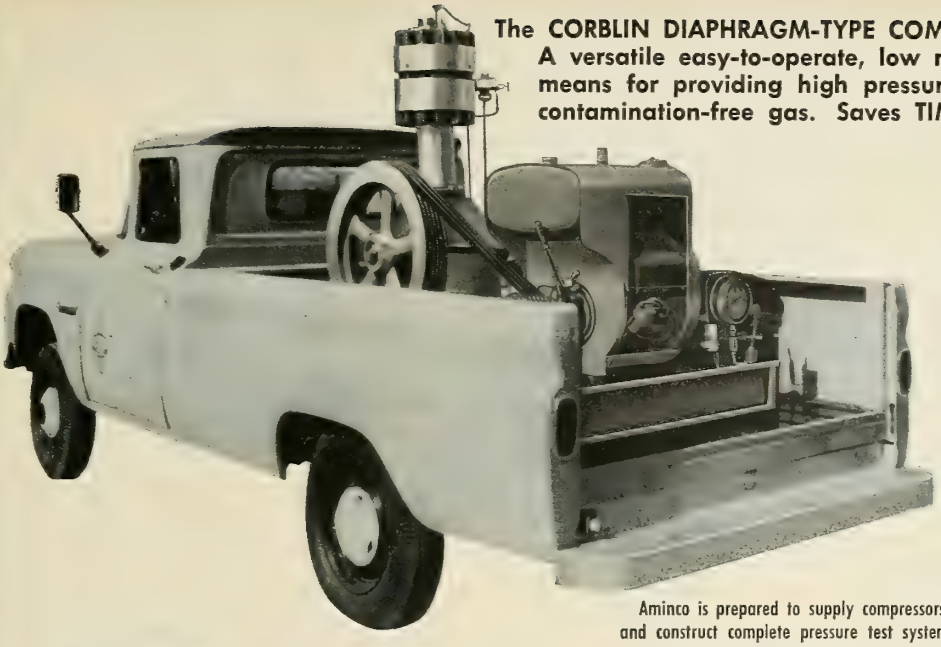

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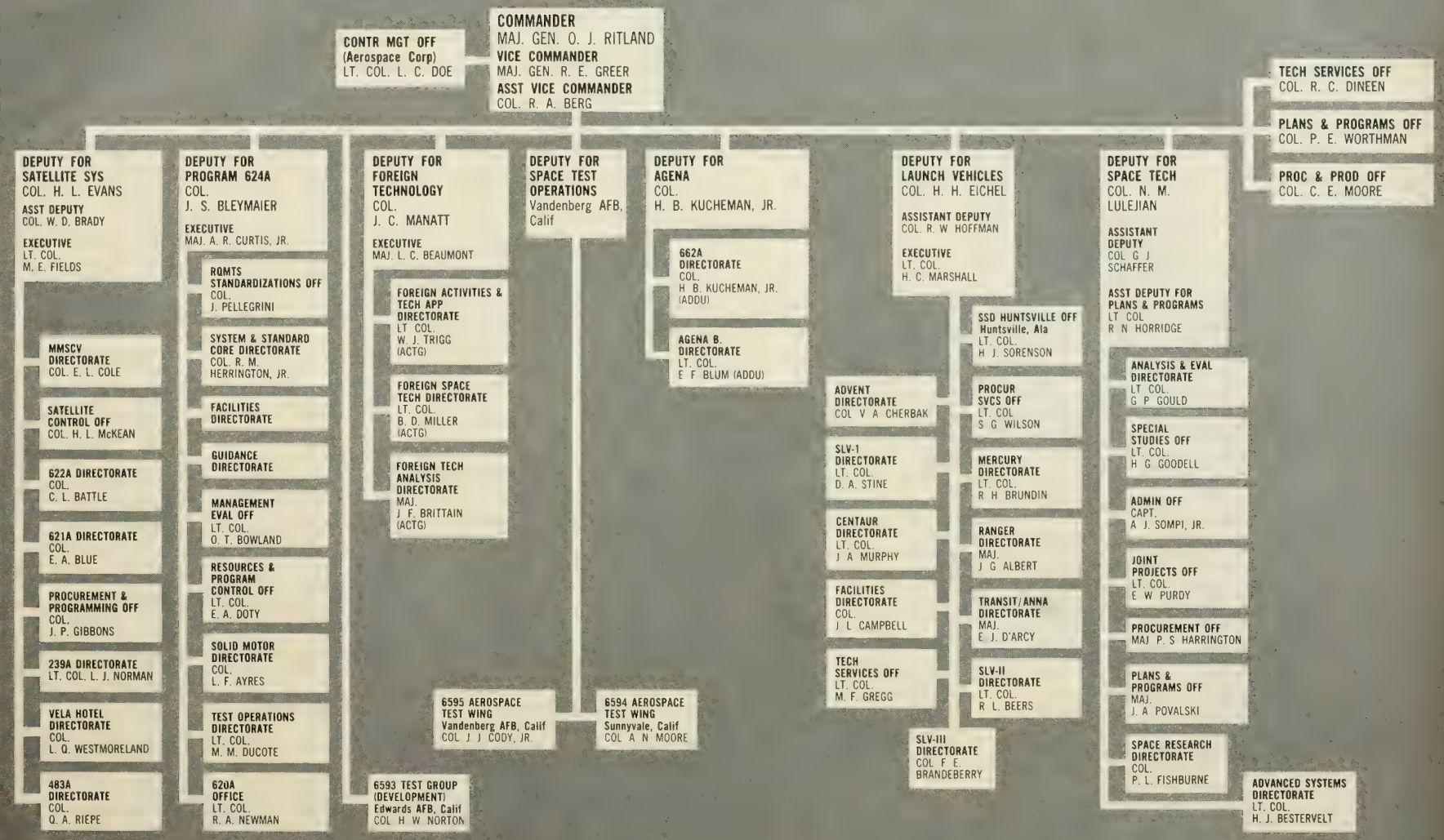


SSD Runs Air Force Space Show

Division is prime contact for companies directly involved in space systems; budget nears $1-billion mark

MANAGEMENT CENTER for almost the entire U.S. military space effort today is the Space Systems Division of the Air Force Systems Command. Some 90% of all U.S. satellite weight in orbit was launched by SSD.

When Systems Command was activated a year ago, SSD was set up to handle the burgeoning requirements of the Air Force space program. It was established from elements of the earlier Ballistic Missile Division of ARDC and Ballistic Missile Center of AMC.

Its alignment on a par with the Ballistic Systems Division was recognition of the then-equal importance of the diverging space and ballistic missile technologies. Within a few years, SSD is expected to far outstrip BSD in size and importance.

Financially, the division already is showing phenomenal growth. In 1957, Air Force space funding in this area totaled about $3 million, much of it spent on 117-L, the program out of which *Discoverer* and *Midas* evolved.

In the coming year, total dollars allocated to SSD will approach the $1-billion mark. The Air Force space program thus has been accelerating—not only in terms of dollars and numbers of programs but in pushing the advanced technology necessary for military space development.

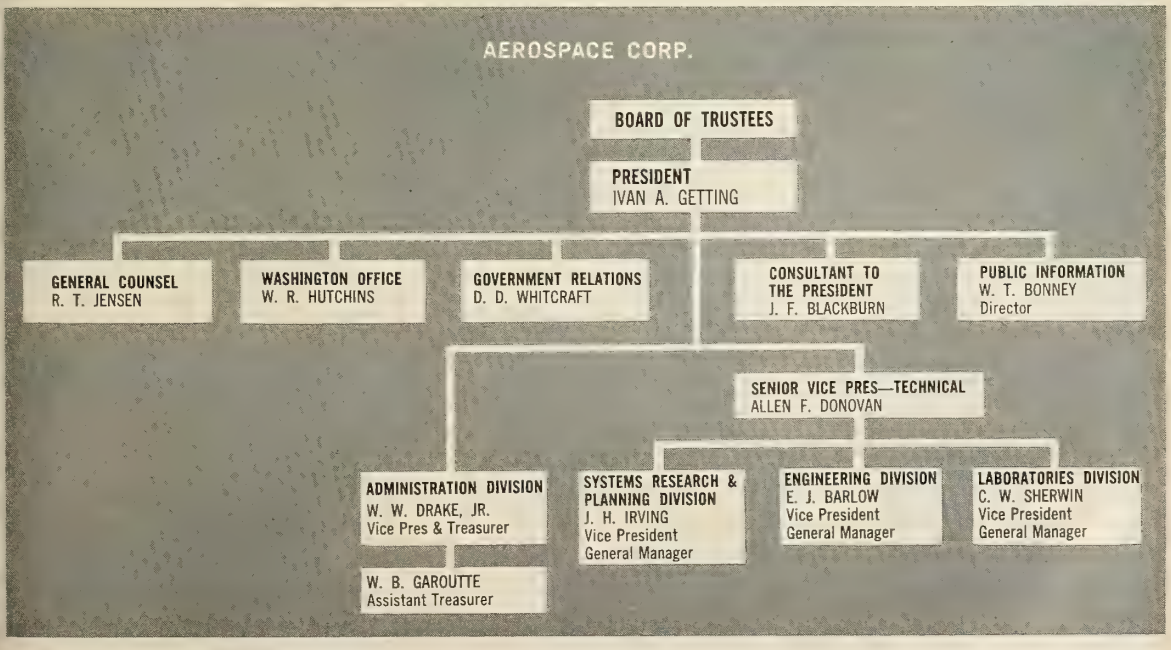
This all has required a management structure capable of anticipating the problems of tomorrow's explosive growth while handling efficiently the problems of today's technology.

To oversee the anticipated shift of personnel and funding—from a BSD shrinking as R&D for ICBM's phases out to an SSD expanding as the Air Force R&D space effort increases—Systems Command created the special post of Deputy Commander of Systems Command for Aerospace Systems (DCAS) under Lt. Gen. H. M. Estes.

Special problems can be handled through special channels to Systems Command and USAF headquarters by Gen. Estes and his staff.

Maj. Gen. Osmond J. Ritland, SSD commander, serves under Gen. Estes.

But, under the decentralization philosophy of AFSC Commander Gen. Bernard Schriever, which has seen systems management shifted from AFSC headquarters to the divisions, the guts of the Air Force R&D space effort is at SSD. For those firms in the industry directly concerned with space sys-



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tems, this means one place to sell, a single point of contact instead of several.

Within the overall Systems Command establishment, SSD is one of six AFSC divisions. In addition to BSD, the others are: Aeronautical Systems Division, Electronic Systems Division, Aerospace Medical Division and Foreign Technology Division.

For assistance in the evolving Air Force space program, SSD draws on these other divisions and, like the other divisions, on the resources of seven AFSC centers: Missile Test Center, Patrick AFB, Fla.; Flight Test Center, Edwards AFB, Calif.; Arnold Engineering Development Center, Tullahoma, Tenn.; Special Weapons Center, Kirtland AFB, N. M.; Missile Development Center, Holloman AFB, N. M.; Rome Air Development Center, Griffiss AFB, N. Y.; Air Proving Ground, Eglin AFB, Fla.

Space Systems Division's mission primarily is one of management, concerned with solidifying the vast spread of space technology into hardware for the operational military space systems of the near and distant future.

To accomplish this, it devotes its attention to five major areas: Applied research and advanced technology; design, development and procurement of space vehicles; launch; on-orbit control and, if necessary, recovery; services for other government agencies such as NASA, Army and Navy.

Management in these areas is the direct responsibility of deputy offices in the SSD organization. These are:

• **Deputy for Space Technology**— This office is concerned with applied research and advanced technology. Under Col. N. M. Lulejian, it is charged with studying what forward steps can be made in space systems, as well as the analysis of current systems for possible improvements.

"This is where we have the Jules Vernes and H. G. Wellses of the 20th Century," says an SSD official.

It is from beginnings in this office that requirements for many of the space systems themselves arise.

• **Deputy for Satellite Systems** — Here rests responsibility for the design, development, procurement, test and delivery of what SSD calls "operable systems." These systems, militarily oriented, include *Midas, Discoverer, Satellite Inspector* and *Vela Hotel.*

• **Deputy for Launch Vehicles** — This, at present, is the outward-looking face of SSD, The launch vehicle office primarily supports NASA, Army and Navy, furnishing boosters and technical support for such programs as *Mercury, Ranger, Advent* and *Transit,* in addition to the Air Force programs. This office has the responsibility for three of SSD's four standard launch vehicles—*SLV-I* (*Scout*), *SLV-II* (*Thor*) and *SLV-III* (*Atlas*).

MAJ. GEN. O. J. RITLAND
Budget nears $1-billion mark.

• **Deputy for Program 624A (Titan III)** — This is the deputy for space booster building blocks, the *Titan III* combination of liquid and solid rockets which will provide varying degrees of thrust for space missions.

This office, the first for standard space boosters, was established recently with the specific responsibility of developing boosters intended for space development work, as opposed to the current practice of using modified ballistic missiles. Under Col. J. S. Bleymaier, it was set up partly in response to the Department of Defense desire for strong, centralized program management.

• **Deputy for Agena**—The task assigned to this office is the development of a "space truck" which can be employed in a variety of systems. *Agena* now is used, for example, in the *Discoverer,* and *Midas* programs, and is scheduled for such programs as *Advent, Satellite Inspector* and *Vela Hotel.*

• **Deputy for Foreign Technology** —The prime interest of this office is in observation of technical breakthroughs in foreign countries. The aim is to discover areas where U.S. systems technology can be improved by exploitation of foreign developments.

• **Deputy for Space Test Operations** (Vandenberg AFB)—This office covers the Aerospace Test Wing at Vandenberg, the Aerospace Test Wing at Sunnyvale, Calif, and the Test Group

(Development) at Edwards AFB.

Function of the wing at Vandenberg can be summed up in one word: launch. This is SSD's space launching agency. Its job is growing as the demands increase from NASA and DOD for help in launching.

In-orbit control and recovery are the responsibility of the wing at Sunnyvale. Currently, it is responsible for command and control of *Discoverer*-type launches from Vandenberg. The wing includes tracking groups throughout the nation as well as the 6594th Recovery Control Group at Hickam AFB, Hawaii, which is responsible for recovery of capsules returning from orbit. The wing also will play a part in the *Advent, Transit, Vela Hotel* and *Satellite Inspector* programs. Personnel from this center, currently manned by both AF and Lockheed Aircraft Corp., are expected to supply the nucleus for operational space groups.

The test group at Edwards AFB provides the rocket test annex for SSD. Here are tested the new and exotic liquid and solid propellants to be used in future space systems. This group works closely with the Deputy for Space Technology and with the Deputy for Program 624A.

How does this sometimes-confusing management set-up operate? In the answer to this question is the key to SSD's management philosophy.

"We make a pretty big man out of the program director," says Col. P. E. Worthman, director of SSD's plans and programs office. "We give him maximum resources, people, money, his own procurement and complete responsibility for the program."

The idea behind this centralized management is to hold responsibility on the operating level, in order to prevent it from "escalating" to higher authority.

Col. Worthman describes how the system works:

"If Col. C. L. Battle in the *Discoverer* office (622A Directorate) needs a booster, he goes to the Deputy for Launch Vehicles and gets his booster. If he needs guidance, he reaches over into ESD for guidance. Then he needs an *Agena,* so he reaches over into the *Agena* Department (Deputy for *Agena*) and says, 'I need this, at this time, get it ready for me.'

"He needs to launch, so he reaches into Col. Cody's shop (Aerospace Test Wing, Vandenberg AFB) and says 'I need a launch.' Then, once in orbit, he says to Col. Moore (Aerospace Test Wing, Sunnyvale, Calif.), 'Give me some on-orbit control.'

"The man in charge of this from beginning to end is Lee Battle. He can delegate authority, but he is still the guy running the team.

"If we miss a capsule in the Pacific, the man who goes to tell the Air Staff about it is Battle. When it's time to meet the President and be congratulated on a success, it's Battle."

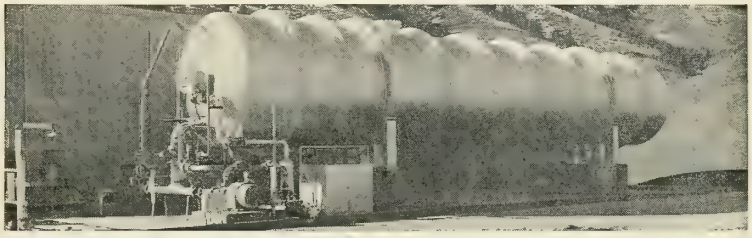
Systems Command operates on "management by exception"—a procedure designed to flag the trouble spots for attention. Once a week, each systems officer stands up with his charts, "looks the commander right in the eye," and reports on how his job is progressing, stating whether it is on schedule and outlining any problems. The charts tell the story: funding, contract initiations, obligations, expenditures, procurement. Red flags indicate the trouble spots.

The PERT management system developed in the *Polaris* program is being phased into the SSD organization—with changes. Its organizational lines will not run all the way to top management.

"If you are going to have PERT, it should belong to the program director," says Col. Worthman.

Assisting Space Systems Division in the management of space programs is Aerospace Corp., the non-profit organization set up in 1960 to replace Space Technology Laboratories in systems en-

(Continued on page 136)



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Space Shares in Harvest from ASD

Although Dyna-Soar is only space system based at the Division, future systems profit from $4-billion/yr. programs

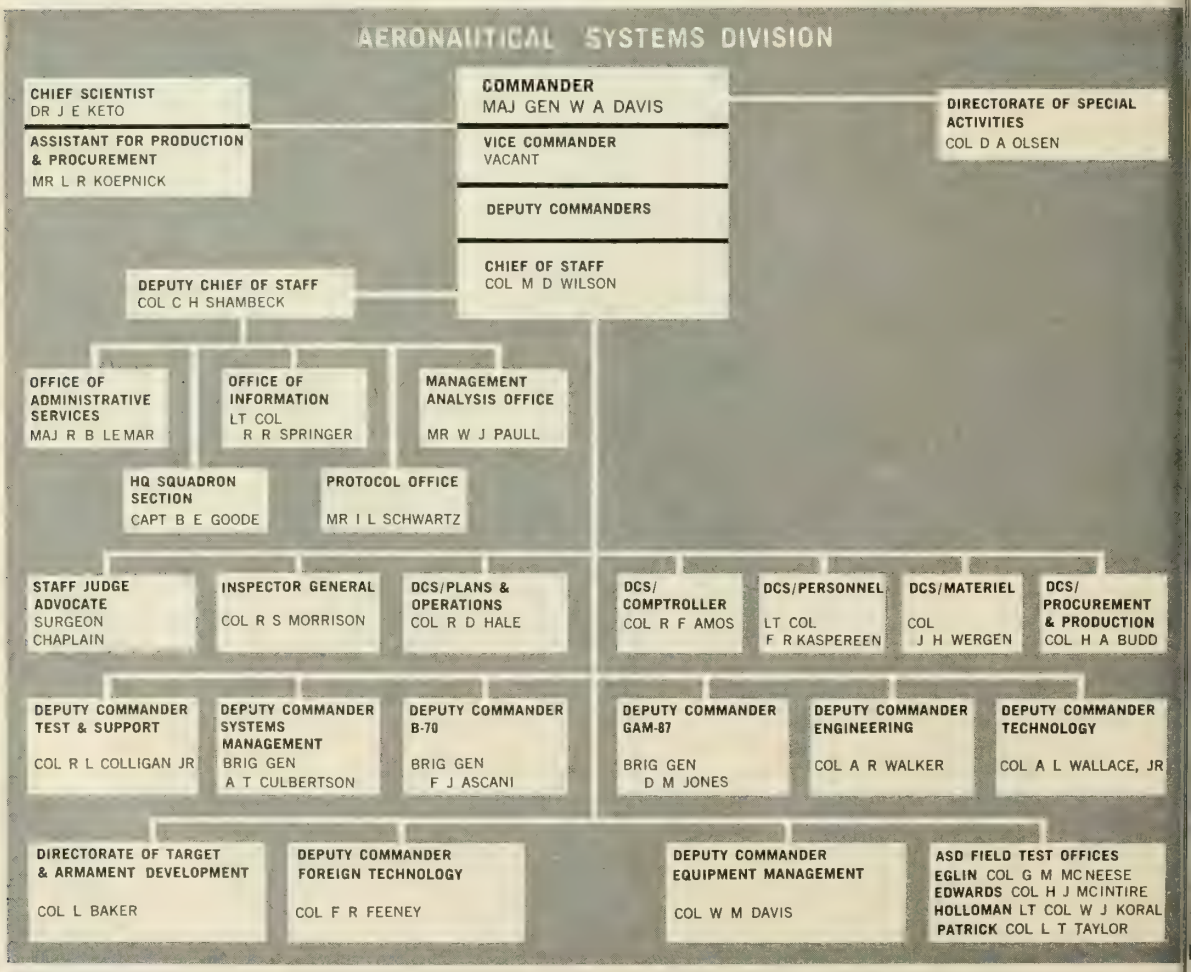
A SMALL, but respectable and growing portion of the more than $4 billion funneled annually through the Aeronautical Systems Division of the Air Force Systems Command to industry is directly related to space.

A large segment of U.S. industry hold ASD contracts—each one designed to push the state of the art in areas the Air Force knows must be developed to meet future systems.

From a mission standpoint, ASD exists to insure a continuous source of new technology and the rapid translation of this into operational military systems.

ASD's specific purpose is ". . . to plan, program, manage and conduct the development, acquisition and delivery of military aerospace systems including aircraft, aerodynamic missiles, missiles associated with aircraft, manned aerospace craft and supporting systems; and to advance the technology required for future Air Force Systems."

ASD is a pedigreed Air Force division—tracing its ancestry back to 1917. The vast Air Force Systems Command grew from the aeronautical explosion in Dayton.



As the facilities were outgrown, arge engine testing moved to Arnold, allistic missile development shifted to nglewood, electronic supporting sys-ems moved to Hanscom, armament to Eglin and Holloman, rocket engine de-velopment, test and aircraft flight test-ng to Edwards, and ground-based re-connaissance to Rome.

The Aeronautical Systems Division s physically located in Area B (Wright Field) of Wright-Patterson Air Force Base, Dayton, Ohio.

Space systems will never provide a arge production potential. By the same oken, many of the particularly rough problems anticipated in all scientific and engineering disciplines can best be at-tacked by small groups either providing he answer or suggesting compromise routes to the systems planners.

ASD's space potential lies in this collection of teams—probing immediate and long-range technical problems but always available for the present head-ache.

• **Double effect**—By far the largest portion of current ASD expenditures goes into aircraft and missiles for tac-tical and strategic uses. It is difficult to distill out the space-system dollar. Many of the programs provide information and guidance in both areas — current weapons technology and future space activity.

The installed cost of ASD's 181 buildings and equipment is approxi-mately $200 million. Under Maj. Gen. W. A. Davis, the organization is di-vided into nine areas of responsibility covering technology, equipment man-agement, foreign technology, target and armament development, engineering, *GAM-87*, B-70, systems management and test and support. A separate re-search management set-up exists and all procurement is handled by a direc-torate. There are also four field test stations at Eglin, Edwards, Holloman and Patrick Air Force Bases.

The only space system at ASD is the *Dyna-Soar*, located in the system program office under the Deputy Com-mander for Systems Management. The main effort compatible with space sys-tems in general is spread through the office of the Deputy Commander for Technology, Col. A. L. Wallace.

The Technology Directorates—Ad-vanced Systems Planning, Aerome-chanics, Avionics and Materials and Processes—are the womb of new Air Force systems. Each has a specific task, yet each supports the other.

A unique Directorate is Advanced Systems Planning. This organization, known as DASP, is composed of expert technical, managerial and production personnel. Its primary job is to turn out packages of information on new systems to aid higher authorities in decisions.

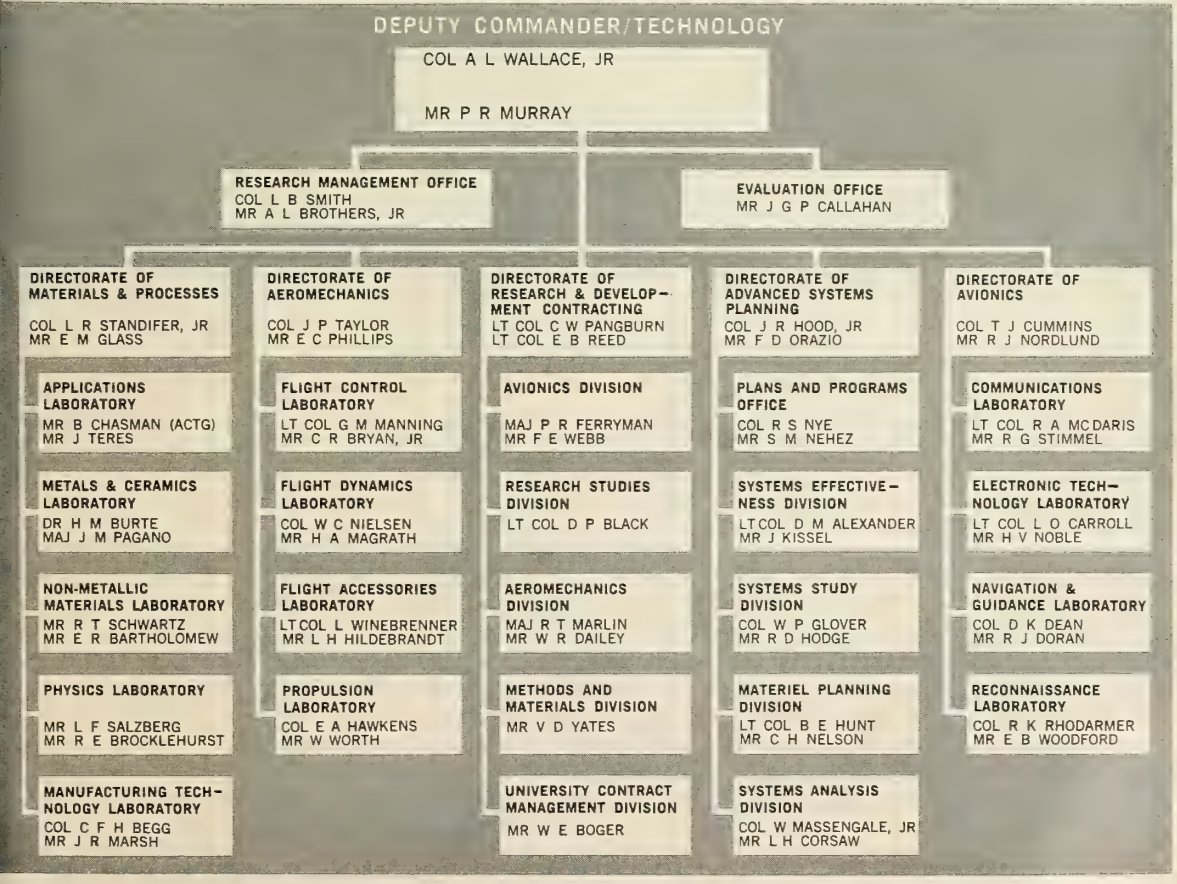
DASP answers questions such as: Is the system necessary? Can it be main-tained? Will it be available within a realistic time period? What are the costs involved? Can it be produced? What is its military value?

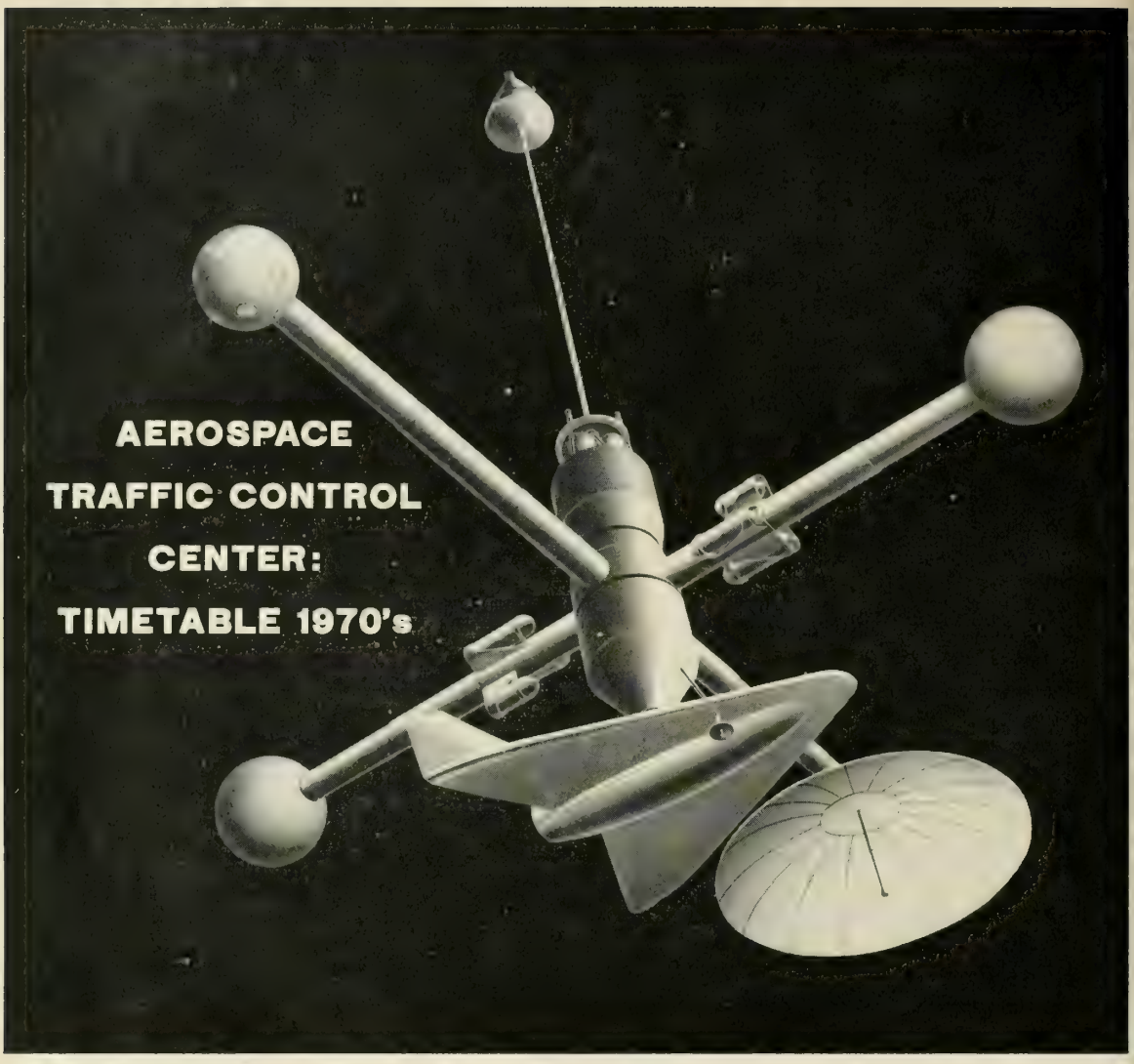
To answer these questions, DASP draws on the resources of the rest of the structure of the Deputy Com-mander/Technology as well as ASD, re-search institutes and industry.

DASP is the only Air Force organi-zation dedicated entirely to the critical evaluation of potential military systems. The group is involved in about 45 sys-tems studies.

These studies include propulsion, global surveillance, earth satellite weap-ons systems, recoverable boosters, air-launched satellite interceptors and others.

One of the products of DASP is a clarification of research and develop-ment areas. Information from this di-





A typical example of advanced design by Lockheed-California Spacecraft

Will command centers based in space be an outstanding development in the ten-year span from 1967 to 1977?

The answer at Lockheed-California Company's Spacecraft Organization is—Yes. Proof: the Spacecraft design pictured here. It reflects the maturity developed in our thinking about manned space systems.

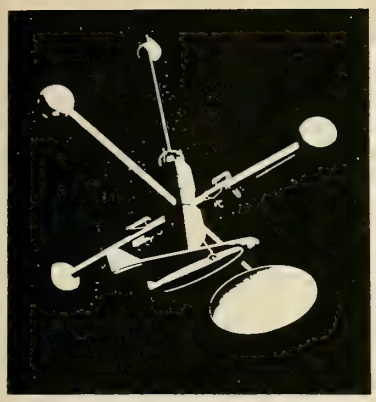
The station—aeroscope traffic control center of the 1970's—will be assembled in orbit in a series of pieces brought together by rendezvous techniques. Included: Command center; living quarters; maintenance station; radar and infrared sensing devices; nuclear power supply; communication links with the earth and other space vehicles. As now planned, 12 people will man the vehicle. Their tour of duty will be measured in weeks.

For four years Lockheed-California Spacecraft has concentrated on the needs of man in space. Activities embrace all fields pertaining to development of such complex spacecraft, as well as related supporting technologies: Space physics (radiation hazards); astrodynamics (rendezvous); biophysics (human engineering); metallurgy and manufacturing processes (materials and structures).

Scientists and engineers of outstanding talent and training are needed to develop the new Spacecraft, Aircraft, ASW concepts of Lockheed-California. If your capabilities lie in the fields listed at right, write: Mr. E. W. Des Lauriers, Manager, Professional Placement Staff, Dept. 1703, Lockheed-California Company, 2404 N. Hollywood Way, Burbank, California. An equal opportunity employer.

LOCKHEED *CALIFORNIA COMPANY*

A DIVISION OF LOCKHEED AIRCRAFT CORPORATION



SCIENTISTS & ENGINEERS

are needed by Lockheed-California to develop new Spacecraft, Aircraft, ASW concepts.

If you are qualified by training and temperament for work in the following fields—we suggest you contact Lockheed at once.

Human Factors
Physics (theoretical, plasma, high-energy, solid state, infrared, optics, nuclear)
Thermodynamics
Servosystems
Reliability
Physical or Bio-Chemistry
Quality and Reliability Assurance
Guidance and Control
Dynamics
Electronic Systems
Aerospace Ground Equipment
Auxiliary Power
Bioastronautics
Communications
Systems Integration and Trade-Off
Space Mechanics
Sub-Systems Synthesis and Analysis
Telemetry
Hypersonic Re-entry
Inertial Guidance
Navigation
Nuclear, Electric and Liquid Rocket Propulsion
Electronics Research
Hydrodynamics

Send resume to: Mr. E. W. Des Lauriers, Manager Professional Placement Staff, Dept. 1703, 2404 N. Hollywood Way, Burbank, California. An equal opportunity employer.

LOCKHEED CALIFORNIA COMPANY
A DIVISION OF LOCKHEED AIRCRAFT CORPORATION

rectorate is a crucial aid to the other tech directorates in planning and guiding their efforts. Conversely, the myriad outputs of the various labs and outside studies are funneled into DASP to help it perform its assigned mission.

Once a system is approved for development, it moves out of the Deputy For Technology and into one of the other deputy command areas within ASD. But before this occurs, everything in the system is checked out and the areas potentially most favorable for development are charted. This even includes manufacturing possibilities.

Most of the current work within D/T aims at operational dates three to ten years from now, and there is a trend towards space in the requirements outlined to the directorates.

The entire applied research program of AFSC is divided into 29 technical areas. ASD's heavy contribution is best illustrated by the following list of 22 representative areas, with the degree of ASD responsibility indicated.

- **Aerospace Support Techniques—100%**

Involves checkout and control methods, site complex support, and the manufacture, handling, containment and hazard control of cryogenic fluids.

- **Aerial Retardation and Recovery—100%**

Developing new concepts permitting the recovery of missiles, related components and payloads.

- **Materials—100%**

Developing new materials concepts and applications (See page 68).

- **Navigation and Guidance—100%**

Develop improved methods of aerospace and spacecraft guidance.

- **Advanced Weapons—100%**

Non-nuclear, vehicle-to-vehicle and vehicle-to-ground weapons.

- **Aerospace Vehicle Propulsion—100%**

Develop advanced propulsion techniques excepting chemical and nuclear rockets.

- **Reconnaissance—100%**

Techniques for sensing, recording, transmission and analysis.

- **Biologistics—100%**

Aerospace Medical Laboratory functions.

- **Human Performance—100%**

Aerospace Medical Laboratory functions.

- **Vehicle Defense—100%**

Techniques for identification, threat evaluation and integration of all defensive measures.

- **Flight Control—99%**

Techniques to control attitude and motion, including sensing and the display of flight information.

- **Mechanics of Flight—93%**

Development and Test of new structures for aerospace and space systems.

- **Electromagnetic Warfare—70%**

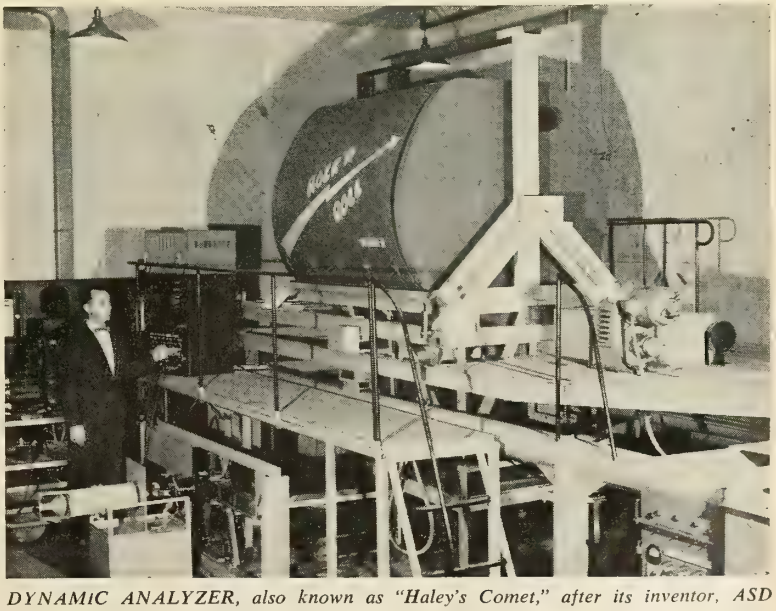
Techniques for jamming, detection, intelligence and counter measures.

- **Electronic Techniques—57%**

Electronics, moletronics and bionics.

- **Computer and Data Processing Techniques—48%**

Improvement of computer components and computer application.

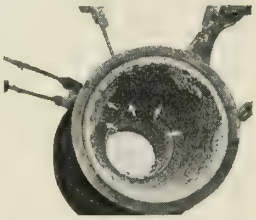


DYNAMIC ANALYZER, also known as "Haley's Comet," after its inventor, ASD engineer James C. Haley, in use at ASD's Directorate of Engineering Test.

Measure TEMPERATURES in a ROCKET NOZZLE??

Yes!! NANMAC Thermocouples have been doing this for years!

For the past 5 years, NANMAC thermocouples have been measuring the inner surface temperatures of rocket nozzle throats and exit cones during actual firing tests.



NANMAC thermocouples are designed to operate even during erosion or ablation. The photo at right shows a rocket nozzle just after a firing test with NANMAC thermocouples installed in the exit cone. NANMAC thermocouples can be made out of such materials as tungsten, molybdenum, graphite, stainless steels, phenolics, plastics, etc. to match identically the thermal properties of the test item.

NANMAC thermocouples can also be used in re-entry bodies, shock tubes, materials evaluation and heat transfer projects. Thermocouples to 5100°F with microsecond response times are available now from NANMAC. Write for details and discover a new concept in temperature measurement.

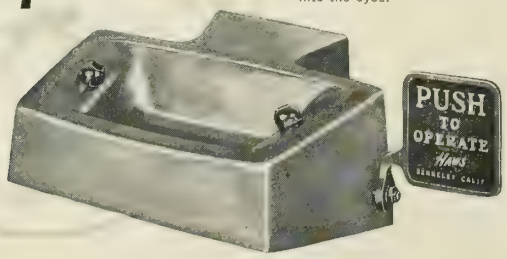
NANMAC CORPORATION
P. O. BOX 8 INDIAN HEAD, MARYLAND

NANMAC THERMOCOUPLES

Circle No. 47 on Subscriber Service Card

SPLIT SECOND SAFETY

Model 7300
Cast aluminum receptor; twin fountain heads direct automatically regulated streams into the eyes.



EMERGENCY EYE-WASH

Sensitive eye tissue can be destroyed in moments. Contamination from industrial caustics and chemicals requires instant first aid . . . and a HAWS Emergency Eye-Wash Fountain can mean the difference between temporary irritation and permanent injury! Write for your free HAWS catalog.

Since 1909 HAWS **EYE-WASH FOUNTAINS**

a product of HAWS DRINKING FAUCET COMPANY 1443 Fourth St., Berkeley 10, Calif.

Circle No. 19 on Subscriber Service Card

- **Communications—33%**
  Improved equipment and methods.
- **Weapon Fire Control—32%**
  New techniques for target search, tracking and firing accuracy,
- **Electromagnetic Vulnerability Reduction—28%**
  Radar anti-jamming and reduced interference.
- **Flight Vehicle Power—24%**
  Development of power sources for aerospace and space vehicles.
- **Electromagnetic Wave Techniques—11%**
  Studies of the transmission of electromagnetic radiation through the atmosphere, space and vehicle "windows".
- **Rocket Engine Propulsion—8.5%**
  Chemical rockets (SSD), Electric Propulsion (ASD)
- **Surveillance Techniques—5%**
  Location, tracking, observation, ground-to-vehicle and vehicle-to-vehicle.

It is obvious that the research program spans AFSC. Management of these programs is independent of the separate Division identities. One man is responsible for applied research in each defined area. This man is known as the Technical Area Manager (TAM).

Two other talented technical types aid the TAM in each area. A Planning Objective Coordinator (POC) monitors applied research aimed at the solution of problems within a single system. He gathers all the various bits and pieces throughout the divisions that might aid in meeting his assigned needs in the particular system.

A Technical Area Coordinator (TAC) represents the TAM in each of the other divisions handling an aspect of the particular applied research program assigned to that TAM. This permits the TAM to coordinate research extending through various divisions of AFSC.

ASD itself accounts for about 20% of the total Air Force budget. Procurements handled by the Division range from manned aircraft, through missiles research, propulsion, production facilities down to parachutes.

Over 7000 new contracts were negotiated and placed during the last year. The time involved in processing these contracts ranges from 0.5 days to 120 days, depending on the complexity of the system or the technology.

Many current Air Force-wide procurement practices originated in this ASD directorate. All Air Force-owned production plants are under this office. Space dollars running through the procurement section are relatively few compared to the established systems expenditures. But again, space systems are still below systems status at ASD except for the *Dyna-Soar*—and this last is being funded as an *X-15* type of operation. ⁂

Signal Generator

Model 412 FM Signal Generator, for check out of command receivers operating in the 400-550 mc band, features direct six-place digital readout of frequency. Accuracy to within 1 kc prevails at any setting throughout the frequency range. Continuous coverage is provided by a single tuning control. The unit is ideally suited for both frequency search and for setting to a given frequency, as well as receiver alignment, bandwidth testing, discriminator measurements, sensitivity measurements, filter attenuation measurements.

Microdot Inc., 220 Pasadena Avenue, South Pasadena, California

Circle No. 20 on Subscriber Service Card

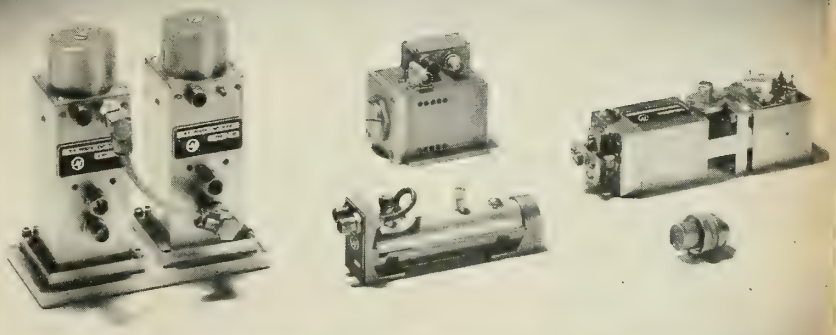
Power Oscillator

These precision units are designed for laboratory use in the evaluation of antennas, calibration power measuring devices, driving of amplifiers, and other applications where higher power ratings are required. Model 410, shown above, offers a frequency range of 500 to 1050 mc direct reading. Power range is 50 mw to 50 w. The unit measures 8″ x 11½″ x 19″ and weighs 45 pounds. Other models cover ranges from 200-550 mc. All components are conservatively rated and carefully arranged for long life and convenient inspection.

Microdot Inc., 220 Pasadena Avenue, South Pasadena, California

Circle No. 21 on Subscriber Service Card

THE "VOICE" THAT CARRIED 22 MILLION MILES



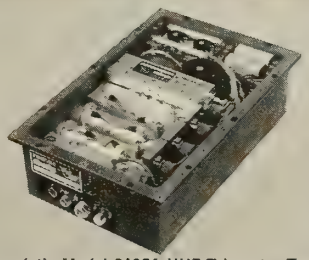
Signals from a two-pound Microdot 150-watt Power Amplifier have been recorded from a solar satellite more than twenty-two million miles beyond the earth... another indication of the proven performance of Microdot rf cavities aboard satellites, ICBM's, and rocket sleds under the most demanding environmental conditions. Dozens of types are available off-the-shelf as standard miniaturized modules, or Microdot can supply cavities to meet customer specifications.

Microdot Power Amplifier Modules are furnished as individual modules or designed into a complete Microdot transmitter, including power supply. Available with power output ranges from 10 to 150 watts and power gain of over 10 db, these units are used as power amplifiers and frequency multipliers.

Microdot Frequency Multiplier Cavities are standard modules assembled in a wide variety of combinations covering the entire frequency range from 100 mc to 3000 mc. Single cavities multiply as high as nine, have been cascaded for even higher multiplication, and will accommodate amplifiers to satisfy power requirements.

Microdot Airborne VHF-UHF Transmitters are complete, integrated systems built to meet your most exacting system requirements. They are comprised of standard Microdot miniaturized coaxial cavity modules (oscillators, amplifiers, and frequency multipliers), power triodes, pulsed oscillators and power amplifiers. Many modifications are possible to provide complete frequency coverage from 100 to 5000 mc.

For more information, write for these illustrated, detailed bulletins: Bulletin PTM-1, JSC-1, and ATC-1.



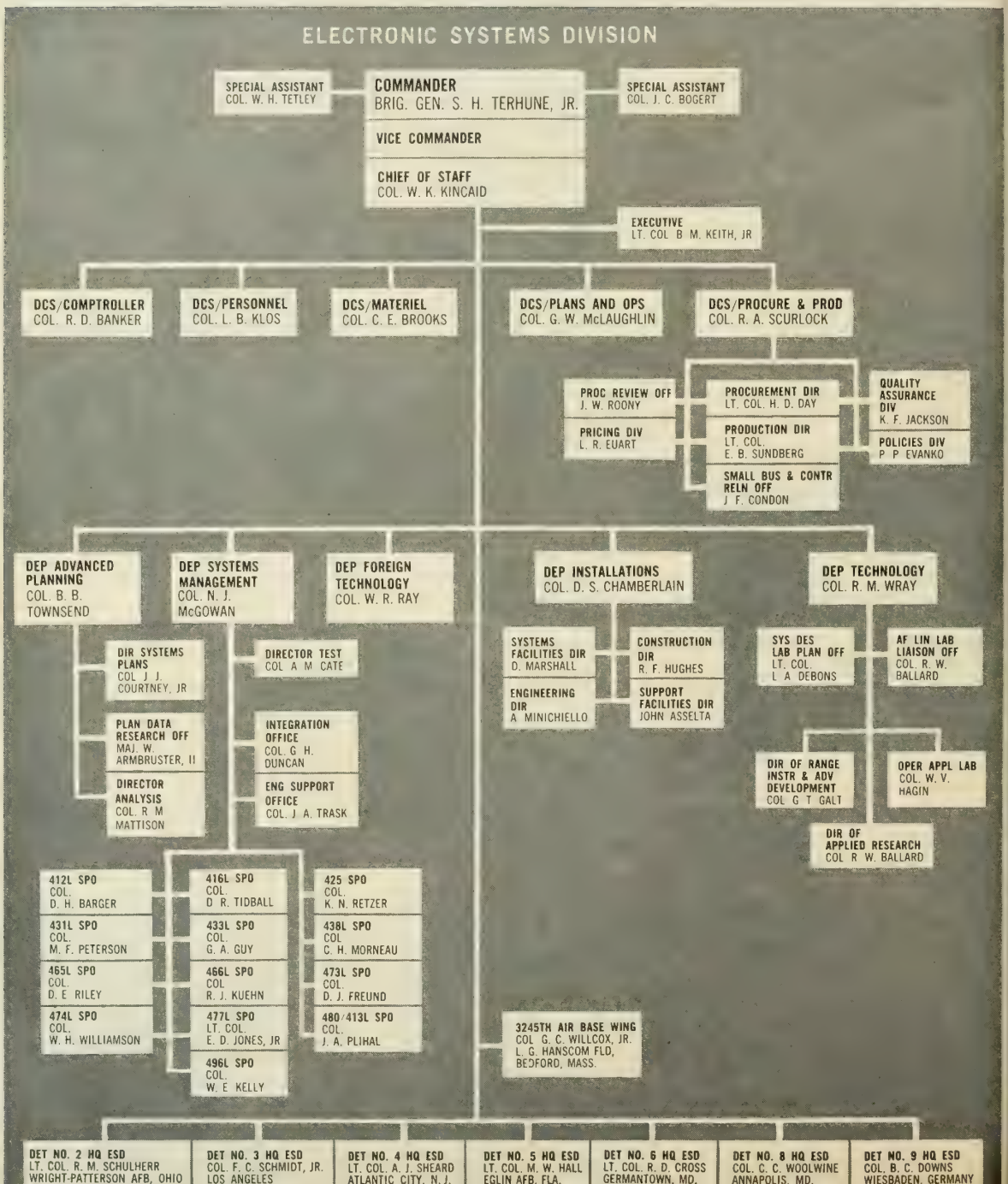
Microdot's Model 2406A UHF Telemetry Transmitter utilizes a unique, automatically stabilized circuit with the output frequency referenced directly to a quartz crystal, allowing greatly reduced size and increased reliability.

MICRODOT INC

220 Pasadena Ave./South Pasadena, Cali

MUrray 2-3351 SYcamore 9-9171

ESD Steps Up Emphasis on Space


ELECTRONIC SYSTEMS DIVISION
SPECIAL ASSISTANT COL. W. H. TETLEY
COMMANDER BRIG. GEN. S. H. TERHUNE, JR.
SPECIAL ASSISTANT COL. J. C. BOGERT
VICE COMMANDER
CHIEF OF STAFF COL. W. K. KINCAID
EXECUTIVE LT. COL B M. KEITH, JR
DCS/COMPTROLLER COL. R. D. BANKER
DCS/PERSONNEL COL. L. B. KLOS
DCS/MATERIEL COL. C. E. BROOKS
DCS/PLANS AND OPS COL. G. W. McLAUGHLIN
DCS/PROCURE & PROD COL. R. A. SCURLOCK
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PRICING DIV L. R. EUART
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PRODUCTION DIR LT. COL. E. B. SUNDBERG
SMALL BUS & CONTR RELN OFF J. F. CONDON
QUALITY ASSURANCE DIV K. F. JACKSON
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DEP SYSTEMS MANAGEMENT COL. N. J. McGOWAN
DEP FOREIGN TECHNOLOGY COL. W. R. RAY
DEP INSTALLATIONS COL. D. S. CHAMBERLAIN
DEP TECHNOLOGY COL. R. M. WRAY
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474L SPO COL. W. H. WILLIAMSON
416L SPO COL. D. R. TIDBALL
433L SPO COL. G. A. GUY
466L SPO COL. R. J. KUEHN
477L SPO LT. COL. E. D. JONES, JR
496L SPO COL. W. E. KELLY
425 SPO COL. K. N. RETZER
438L SPO COL. C. H. MORNEAU
473L SPO COL. D. J. FREUND
480/413L SPO COL. J. A. PLIHAL
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DET NO. 2 HQ ESD LT. COL. R. M. SCHULHERR WRIGHT-PATTERSON AFB, OHIO
DET NO. 3 HQ ESD COL. F. C. SCHMIDT, JR. LOS ANGELES
DET NO. 4 HQ ESD LT. COL. A. J. SHEARD ATLANTIC CITY, N. J.
DET NO. 5 HQ ESD LT. COL. M. W. HALL EGLIN AFB, FLA.
DET NO. 6 HQ ESD LT. COL. R. D. CROSS GERMANTOWN, MD.
DET NO. 8 HQ ESD COL. C. C. WOOLWINE ANNAPOLIS, MD.
DET NO. 9 HQ ESD COL. B. C. DOWNS WIESBADEN, GERMANY

in Its Long-Range Planning

Massive facilities and highly trained staffs enable division to handle sweeping assignments; Mitre Corp. is second strong arm; 60% of R&D awards go to industry

OVER HALF of the $1.9 billion in contracts for which the Electronic Systems Division, Hanscom Field, Mass., is responsible are associated at least in part with the growing Air Force space effort.

The majority of ESD's advanced planning, however, is directly concerned with future requirements in space.

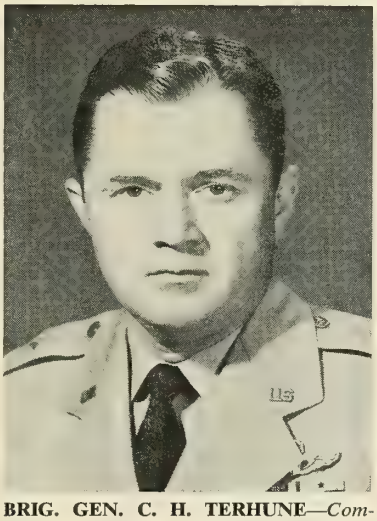
With its vast complex of "L" systems for command and control, with its current emphasis in integrating all C&C systems into a single functional entity, and with its unusually large assemblage of technical talent, Electronic Systems Division appears capable of accomplishing its future space tasks without internal change.

To maintain concurrency and to assure complete systems integrations, AFSC has directed that all division commanders "will require that any weapon or support system conceived, designed, or developed for operational employment or carried through to hardware stage be completely staffed and coordinated through and with the Electronic Systems Division as a procedural requirement."

ESD is charged primarily with the development of all AF command and control systems necessary for data collection, processing, transmission, and display; other developments necessary to permit weapon command and executive control associated with AF aerospace operations; and development of test-range instrumentation required to test those systems.

In addition, ESD is responsible for conducting for the USAF and other national intelligence agencies an aggressive R&D program for intelligence techniques, equipment, and systems.

In AF systems development, ESD's role begins at the conceptual stage. It must determine requirements for command and control and their integration with each weapon system. Even after a system becomes operational, ESD may continue to assist in providing system improvements—both in operational techniques and hardware.



BRIG. GEN. C. H. TERHUNE—*Commands farflung ESD developmental network.*

• **Functional organization**—The present ESD commander is Brig. General C. H. Terhune, Jr., who succeeded Maj. Gen. K. P. Bergquist in February. His vice commander has not yet been named.

Terhune's Chief-of-Staff is Col. W. K. Kincaid.

Answering directly to the executive office are three major operating deputies for Advanced Planning, Systems Management, and Technology. In addition, there is a deputy for Foreign Technology and one for Installations.

Complementing the three principal operating groups at the Hanscom Complex are the Cambridge Research Laboratories of the Office of Aerospace Research (see p. 122) the Lincoln Laboratory of M.I.T., and the Mitre Corp.

Finally, the extensive laboratories and vast electronics development capability of Rome Air Development Center at Rome, N.Y., are employed by ESD. Although it is no longer a part of ESD administratively, Rome will continue to work closely with the division. According to AFSC, there will be no change in manpower, funding, or mode of operation with the recent return of RADC to the direct control of Systems Command.

Six small ESD Detachments for liaison are scattered across the country, and there is a seventh in Wiesbaden, Germany.

Total authorized ESD complement is just under 1600.

Housekeeping at Hanscom is provided by the 3245th Air Base Wing (with personnel total of 2736).

Total ESD Fiscal 1962 budget was approximately $850 million. Of this total, $513.2 million was for research, development, testing and evaluation (RDT&E) and equipment for the "L" systems (command and control); $130 million was for R&D; and over $2.8 million for new construction.

Budget authorization over the next five years is expected to increase moderately. Personnel requirements are expected to increase at a rate of from 4-5%/year.

• **Advanced planning**—The ACE concept (Aerospace Control Environment) sets the pattern for the Advanced Planning Office. ACE is concerned with the integration functionally of all command and control systems, now and in the future. SPADATS (Space Detection and Tracking System) is the beginning of such a complex systems approach. (It is the core around which 496L, Space Track, will be built over the next few years.)

The task of this planning group is to look ahead for 5-15 years to determine future requirements. This might be de-

(Continued on page 143)

AMD Beefing Up Facilities and Staff

To meet expected acceleration of bioastronautics effort, headquarters is doubling plant and busily recruiting

AEROSPACE MEDICINE Division's headquarters at the School of Aerospace Medicine, Brooks AFB, Tex., is physically symbolic of the Air Force's intention to step up its bioastronautics capability.

The flurry of construction all over the grounds of the School will double the School's area by mid-1963. Funding of the additional buildings—over $6 million—will bring the cost of constructing aerospace medicine facilities to over $42 million over the years. And almost all of this property has increased in value.

The School plans to add substantially to its payroll to man the new laboratories. Some four or five hundred technicians and laboratory personnel will be recruited in the next year and a half. The AF bioastronautics program already maintains some 1300 people—over a third with professional degrees.

• **Mostly in-house**—Officials at the School are expected to continue their policy of letting a little less than half of their research to industry. The rest is done in-house.

The School currently is interested in research in space-cabin simulation, water problems in spaceflight, planetary environments, weightlessness, some research on algal systems, cosmic radiation, small-animal biopak development, audio and visual problems, vector-cardiography, adrenal function and stress, fat embolism and irradiation and bacterial invasion.

General areas in which the School expects to continue research are radiation studies, life support systems for spaceflight, practice of medicine in space, human performance studies and basic research in the biosciences.

Large pieces of equipment such as motion simulators will continue to come from industry.

• **Old wooden school**—SAM now has some 47 buildings with 460,000 sq. ft. of floor area. The School's principal activities are conducted in five almost new buildings. However, some must be carried out in the School's 36 old wooden buildings, which are scattered all over the base.

BRIG. GEN. T. C. BEDWELL, JR.
Heads mushrooming AMD organization.

Since the old buildings are not equipped with special equipment for laboratory work, the new buildings are badly overcrowded. The Research Institute houses the one- and two-man simulators, supply services, part of the audiology laboratory, offices of the school commandant and his staff, the high-level cobalt-60 radiation facility, a laboratory for studying potentially infectious agents, laboratories for microbiology-cellular biology, pathology, toxicology, pharmacology, space medicine, veterinary services, and a 47,000-volume library.

Six new buildings will be completed by next summer. A separate library building will double the present capacity. A new bionucleonics building, far from the School's "hot wing," will house a whole-body radiation counter for exact measurement of the radiation present in each subject's body. This heavily shielded structure will make possible precise counts of radiation received in such negligible exposures as flights of the *X-15* and high-altitude balloon flight.

• **To 50 g's**—A 20-ft. arm centrifuge with a manned gondola will be the prime research feature of the new bioastronautics-biodynamics building. This centrifuge will be capable of accelerations up to 50 g's in less than a minute.

Norair's rotating, frictionless sphere (M/R, Oct. 15, 1961) is expected to be delivered and operating by completion of construction.

Several multi-manned simulation chambers also will be installed in this building. Many Air Force bioastronautics officials have indicated that they will always be interested in simulators which can realistically simulate as many of the stresses of spaceflight as possible.

The new professional building will take on the job of keeping the Air Force's huge files of medical data on each of its flight personnel. Computer equipment in this building also will be used in research work in conjunction with laboratories at the School.

The School already has demonstrated its excellent capability in the development of small animal biopaks for space flight. This work and other animal studies will be implemented with the new vivarium. These programs cover the baseline studies including oxygen consumption, carbon dioxide output, food requirements, water metabolism and nitrogen balance in animals such as mice, squirrel and rhesus monkeys, chimpanzees and man himself. ⠿

Circle No. 22 on Subscriber Service Card ⟶

SURVIVABILITY*

Success of a military mission is measured in terms of accomplishment. For manned and unmanned aircraft, a major parameter of accomplishment is survivability (*ability to fly to, and return from, the target).

Survivability is currently being studied at very low altitudes. Texas Instruments Incorporated, working with the U.S. Army Signal Corps, the Air Force, and prime aerospace contractors, conceived and developed a completely automatic low-altitude navigation system. This system is light, simple, and relatively inexpensive. It flies the aircraft accurately over an extremely low-altitude terrain profile . . . automatically!

For complete technical information, write Apparatus Division, Texas Instruments Incorporated, P. O. Box 6015, Dallas 22, Texas. Qualified "NEED TO KNOW" respondents only, please.

Thousands of miles of completely automatic terrain following flight are being logged each month.

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AND HOUSTON, TEXAS

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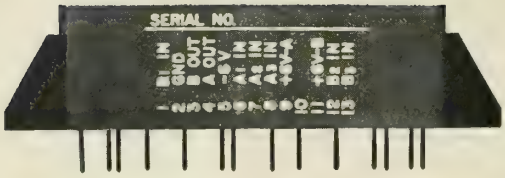

In less time than it takes light to cross this room, a new product, **DELCO'S NEW** high speed **10 MC** silicon modules, could: (1) correct the course of a missile in flight; (2) make it possible for sonar pickups to track and compute the position of targets with microsecond accuracy; and (3) handle any number of other airborne guidance and control functions that previous modules—due to low speed or environmental or performance limitations—could not handle. Delco Radio's 10mc modules, with a maximum gate-switch speed of 40 nanoseconds, convert data 100 times faster—even under the most extreme environmental conditions.

These **SILICON** modules come epoxy encapsulated, and operate over a temperature range of −55°C to +100°C. And these same reliable **DIGITAL** circuits are available packaged on plug-in circuit cards. These Delco **MODULES** are environmentally proved to: **SHOCK**, 1,000G's in all planes. **VIBRATION**, 15G's at 10 to 2,000 cps. **HUMIDITY**, 95% at max. temp. **STORAGE AND STERILIZATION TEMP.** −65°C to +125°C. **ACCELERATION**, 20G's. Designed for systems using from one module to 100,000, and the module's rated performance considers the problems of interconnection. Data sheets are available. Just write or call our Military Sales Department.

Physicists and electronics engineers: Join Delco Radio's search for new and better products through Solid State Physics.

PIONEERING ELECTRONIC PRODUCTS THROUGH SOLID STATE PHYSICS

Division of General Motors • Kokomo, Indiana

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SEE YOU AT IRE SHOW, BOOTH 1423

Circle No. 23 on Subscriber Service Card

RADC Broadly Involved in Space

Research and development at heavily funded center covers half-dozen astronautics areas, including satellite reliability

ALL FOUR of the operational directorates of Rome Air Development Center are associated with the Air Force space effort.

Under the command of Maj. Gen. D. C. Doubleday, RADC has the extremely broad mission of performing electronics applied research and development for aerospace and defense systems.

With a current budget of over $100 million, RADC generalized programs and effort as a percentage of total dollars authorized are: Systems Support, 15%; Operational Support, 5%; Data Acquisition, 25%; Communications, 20%; Data Processing, 20%; Display and Engineering Support, 15%.

Of the almost 1600 personnel at RADC, over 700 are engineers and scientists. Total FY '62 R&D budget is about $95 million. Roughly 18% of the total RADC R&D effort is in-house.

To indicate some measure of the breadth of this vast applied research facility, the present USAF inventory at Rome is well over $400 million.

Four technical areas make up the principal research task at the Center—data acquisition, processing, transmission, and display. Functionally these areas are handled by four major directorates: Engineering, Guidance and Control, Communications, and Intelligence and Electronic Warfare.

• **Engineering**—Two principal R&D efforts are maintained within the Directorate of Engineering—data display and electronics reliability. In addition to these, Engineering provides technical support to the other three mission directorates.

The group, comprised of 240 persons, operates under the direction of W. P. Bethke. Eleven different disciplines are handled by Bethke's staff in three laboratories: applied research, development engineering, and human engineering. Forty percent of the R&D performed by Engineering is accomplished in-house, mostly in the Applied Research Lab.

Important fields of interest in R&D associated with space are microminiaturization, radiation effects on man and components, large dynamic displays, man/machine relationships, high electrical power generation, and—of major concern—satellite systems reliability.

Finally, it is the lead directorate for ESD's 477L program, Astrec (Atomic Strike Recording) and Nudet (means for detecting nuclear detonation).

• **Guidance & control**—The Directorate of Guidance and Control, headed by Col. J. B. Bryant, is chiefly concerned with data acquisition. Thus it makes use of radar and microwave technology in developing systems and techniques for detection, tracking, recognition and identification, plus command and control up to the kill phase in weapon systems.

Major areas of research include radar application of optical frequencies, super amplifier power tubes, plasmas, space detection and tracking (496L), adaptive radar techniques, techniques for signature studies, ground systems for space guidance and control, libration point surveillance systems, electromagnetic propagation studies, and high-power break down phenomena.

G&C is the principal directorate for supporting the 473L program.

The directorate is comprised of three laboratories for control systems, space defense systems and techniques.

• **Communications** — Col. L. N. Palmer leads the Directorate of Communications. It, too, employs three labs (advanced development, equipment, electromagnetic vulnerability) plus a communications planning office.

Concerned with data transmission, all facets of advanced communications systems, subsystems and techniques, it is directly associated with all of the ESD command and control systems integration.

A principal assignment in the directorate is the passive satellite program directed by NASA. Much of its work has been centered on the antenna problem associated with the *Echo* project.

• **Intelligence and EW**—The fourth area of technical concern to RADC is data processing, handled by the Directorate of Intelligence and Electronic Warfare.

Also divided into three functional labs, I&EW is directed by Howard Davis.

Information Processing Lab is concerned with advanced development in all areas of data handling, storage, retrieval, and processing, and thus supports all of the L systems making use of such techniques.

Principal research areas include development of associative memories, hybrid systems, improved man/machine computation techniques, adaptive processing systems for reconnaissance-data information extraction, multi-sensor approaches to recon interpretation.

The other two labs for QRC (Quick Reaction Contracts) and EW (Electronic Warfare) are associated in missions. QRC handles a vast number of small electromagnetic-intelligence R&D programs.

These generally are efforts that can be placed in industry for development in time periods under nine months. Hardware contracts run about $15 million/year and are valued from $1000-$100,000.

Of the 32 existing major efforts, six are being performed in-house. Although much of the work is for ground systems, some are associated with Strategic Air Command flight requirements.

The EW Lab program is concerned primarily with electronic countermeasures. Its largest effort is supporting the 466L program.

Other major studies include fundamental plasma-sheath and propagation-medium research. ⌗

AMR Cost: $2.54 Billion Through '66

Future space requirements will call for more tracking ships and instrumentation satellites; Titan III complex to be built

GREATLY INCREASED reliance on tracking ships and the eventual use of instrumentation satellites is expected to provide wide flexibility for the handling of future space vehicles on the Atlantic Missile Range of the Air Force Missile Test Center.

The tracking ships, ARIS (Advanced Range Instrumentation Ships) using the Navy's *Transit* satellite to achieve high positioning accuracy, will spark the shift to sea-based mobility.

Another major move will be the construction of a three-pad launch complex for the *Titan III* booster.

The high cost of Space-Age manned and nuclear systems, plus the need for real-time telemetry, will push the total investment in AMR facilities to $2.54 billion by the end of Fiscal 1966. Present capital plant investment is only $1 billion.

The *Titan III* complex will be built inside the new NASA land acquisition area at Cape Canaveral. Air Force plans call for the construction of three pads, but it is possible that only two will be built.

The pads will be an "integrated" facility in which the vehicle and its payload will be assembled in an industrial facility and moved to the pad by rail. While no final decision has been made, it is expected that each pad will also have a gantry which will also be movable by rail.

Instrumentation satellites may well fill the need for real-time telemetry in manned vehicles. In some thinking, the satellites—possibly manned—will orbit the earth in the plane of what is now the AMR/PMR global network.

(Details of the AMR/PMR global net were laid out by M/R on Nov. 21, 1960, pp. 12-15).

Direct communications between all points will be essential for large-scale manned flights, and boost-phase control may be made a responsibility of this satellite system.

Until such a sophisticated system comes into the picture, however, the ARIS will bear an increasing burden of responsibility for data acquisition. Positioning of the 10-15 ships will be achieved through the *Transit* system used by the Navy, which has established tracking and other facilities for this satellite system in the Philippines. It is capable of servicing ships operating in the Indian Ocean.

• **ARIS program growth** — Vessels numbered 1 and 2 of the Advanced Range Instrumentation Ships program are now about two-thirds completed, according to Air Force officials. Sperry-Rand Corp. and Air Force only recently definitized the prime contract, although Sperry has been working for some time on a letter contract.

A PERT-type management structure and control mechanism has been established to handle what many believe will be the most sophisticated instrumentation ships ever developed.

Completion date is scheduled for late 1962 for #1, followed in 45 days by #2.

Conversion of the World War II troop transports is now in advanced stages of completion at Bethlehem Steel's shipyard in Brooklyn. Installation of the heavy load of electronic instrumentation is now under way.

The 14,300-ton, 520-ft.-long vessels will each carry a civilian ship's crew of 100 and an instrumentation group of approximately the same size, which is aimed at extending the AMR to 10,000 miles. Prime contractor for the program is Sperry Rand Corp.

Ships 3 and 4 are expected to be funded for FY '63.

In all, present AMR plans call for a total of 10 range ships—ARIS 1 through 6 will be "master" ships, ARIS 7 through 10 will be satellite vessels. The master ships will carry continuous-wave transmitters, the other four will carry range and range-rate instrumentation. Up to 15 ships may be needed.

The first four vessels are expected to carry:

C-band Radar (single mode of polarization, beacon, or skin track).

Telemetry (automatic track, receive, record from 200 mc to 14 kmc).

Timing System (synchronized to AMR timing).

Command Control (antenna slaved to 406-450 mc trackers).

In addition, each ship will have a complete operations control center, complete communications facilities covering all necessary frequencies, a meteorological center, a data processing system, and a stabilization/navigation system. The latter will provide passive stabilization position to ± 50 ft. and true heading accurate to 30 seconds of arc.

Ships 5 and 6 will carry L-, C-, and X-band radars, and an improved timing system accurate to 100 microsecs, together with systems similar to those of the first four vessels. They will not have complete control centers.

• **Glotrac system**—Another new system, developed jointly with the Pacific Missile Range, is called Glotrac. This will be a global tracking system to provide position and velocity data of space vehicles in rectangular coordinates.

The system was designed to meet the stated requirements of *Centaur* and *Advent* and, in general, is for fixed-orbit vehicles. It is expected to go operational in December. Where possible, elements of this system will be designed as air-transportable units. Very long base lines are used between stations.

Built by General Dynamics/Astronautics, the system is described by AMR spokesmen as "the next step in providing ever-increasing instrumentation accuracy."

• **MISTRAM system** — General Electric's Missile Trajectory Measurement (MISTRAM) system is due to become fully operational at Cape Canaveral by mid-1962.

Accuracy of the system is sufficient to detect a range measurement for a vehicle with extreme accuracy over a distance from 20 to 1000 miles. The

1000-mile-maximum was an interim figure intended to give immediate coverage for the *Minuteman* program. Range of the system will soon be increased.

MISTRAM operates independently of all other range systems, acquires a launched vehicle, tracks it through space, measures its position and velocity vectors in real-time, and simultaneously transmits these data to external computer facilities while recording it on magnetic tape for post-flight analysis. It thus fulfills the basic requirements for trajectory data and range safety information.

First installation of MISTRAM is at Valkaria, about 30 miles south of Cape Canaveral. It utilizes an L-shaped pattern with two 10,000- and two 100,000-ft. baselines. Two 10,000-ft. remote stations are physically connected to the central station by cable and waveguide. The other two stations, at 100,000 feet, are electrically connected to the central station by microwave link.

Coverage of the system can be extended as requirements for future programs materialize.

According to GE, MISTRAM represents an order of magnitude improvement in accuracy over any other system in existence. "Fully processed data on a ballistic missile at a range of 350 miles, elevation angle of fifteen degrees, and suitable velocity for a 5000-nautical-mile ballistic trajectory would produce velocity component errors of a few tenths of a foot per second, and an impact prediction with a CEP (circular error probability) of only 300 feet," the company said, "since the errors involved are less than the dimensions of the missile."

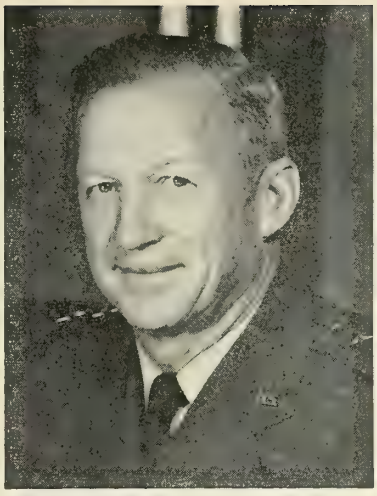
The company also points out that these errors include all known sources of error, "including a nominal uncertainty in the velocity of lights."

By modification of the missile antenna to 14 inches, the system would have enough antenna gain to provide tracking at 250,000 miles. For a lunar impact prediction, the system will provide a CEP of less than five miles on a reasonable trajectory, and this does not include midcourse or terminal guidance.

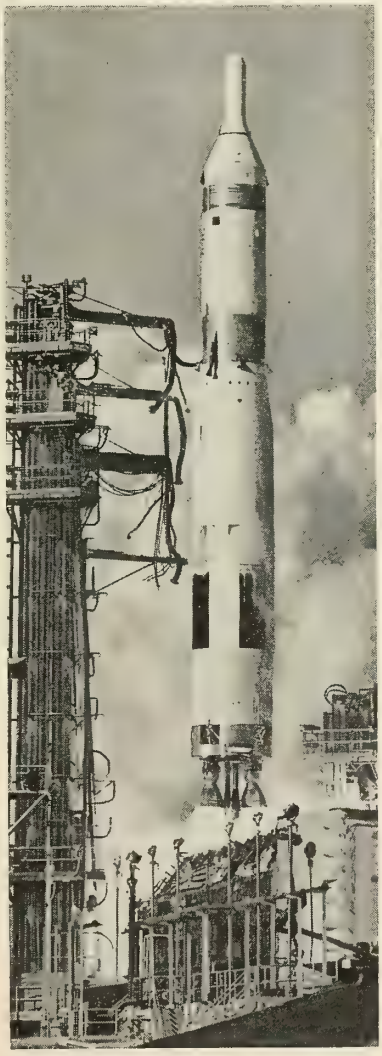
Placing a MISTRAM transponder on the moon with a directional antenna pointed properly could, GE feels, reduce the uncertainty regarding the moon's ephemeris to about one mile.

Techniques for boosting range to more than 250,000 miles include modification for increased ground transmitter power, increase of receiver sensitivity through use of parametric amplifiers, and an increase in antenna directive gain.

A standard tracking antenna at the MISTRAM central station is used to acquire the vehicle, track its flight and transmit signals to the missile beacon. Five receiving antennas, one at the central station and one at each of the four remote sites, are slaved to this tracking antenna so that they also follow the vehicle and receive signals from its beacon.



ABOVE: *Maj. Gen. Leighton I. Davis commands the Air Force Missile Test Center.*
BELOW: *A Titan I lifts off from the Cape. Three Titan III pads are planned at AFMTC.*



Measurement of the phase shift between the transmitted and received signals at the central station is used to determine range. Measurements of the differences in phase shift between signals received at the central station and those at the remote stations will yield range differences to define vehicle position in space. Measurements of the rate of change of range and four range differences are used to determine vehicle velocity.

It is expected that by refining scientific knowledge of such basic items as the speed of light and the precise distances between instrument stations, overall range accuracy and reliability will be significantly increased.

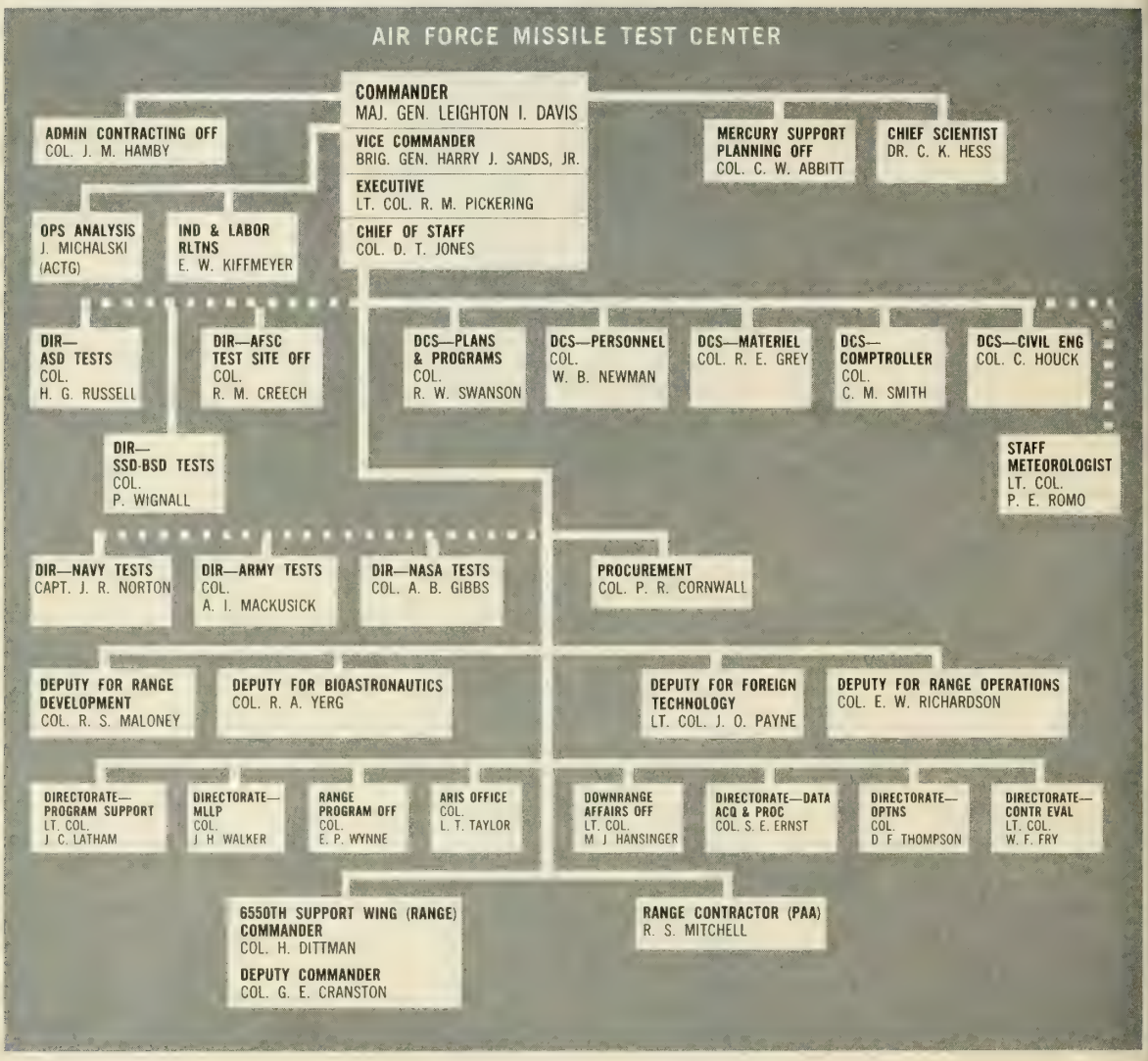
• **Budget increases** — The present capital plant investment in AMR—approaching $1 billion—has reached its level from a figure of $27 million in June, 1950. At the fiscal year ending June 31, the range will have about the following total investment: 1962, $1.097 billion; 1963, $1.616 billion; 1964, $1.940 billion; 1965, $2.39 billion; 1966, $2.543 billion.

These figures include investment in real property and equipment such as blockhouses, range vessels, and instrumentation. It does not include vehicles, and no allowance is made for appreciation or depreciation of capital plant.

Permanent work force at the range, including military, civil service and contractor personnel (but not construction workers) will draw $199.3 million in payrolls by June, 1966, compared with the present figure of $158.9 million and the June, 1950, level of $2 million.

Coupled with the current procurement rate of $180.9 million, the construction and real property expenditures and the payroll level, this fiscal year's AMR spending comes to $493.9 million. The FY '62 figures include the National Aeronautics and Space Administration's purchase of land for $80 million, and AMR's procurement of MISTRAM equipment and the first two vessels for the ARIS program.

AMR now has roughly a 26,000 working population, contrasted with the 1163 it had in 1950. This includes 13,200 at Cape Canaveral, 8700 at Patrick Air Force Base, and 3900 downrange. About 3000 are civil service, 4500 military, and the remainder are contractor personnel, including 1600 construction workers.



AMR is represented on the Range Commander's Conference. This group attempts to standardize range operations, equipment and procedures, and serves as a "tie-together" of all national ranges. This level also tries to determine how each range ties in specifically with the national range system for each specific project. How each project affects each range and what each range's responsibility will be for each project—*Dyna-Soar*, for instance.

The system works something like this: for example, Edwards AFB is subservient in *Dyna-Soar* to the "lead" or launching range, AMR is charged with working out the Master Plan for the project, and coordinating these plans with the other ranges. Any of the other ranges can coordinate plans on a specific project with that project's SPO at Wright-Patterson.

• **Study programs**—In addition to its standard range operations, AMR is planning several major study programs.

One is a proposed study to examine the use of high-altitude aircraft, rockets, and satellites as targets for instrumentation calibration and error analyses. The goal is to improve present mathematical models and to define required sample sizes for various missions.

A second is based on existing needs for the accurate prediction of plasma effects on AMR instrumentation. Range officials have proposed a study to develop criteria for minimizing these effects on future instrumentation systems.

A third is a planned study of the refraction effects on range instrumentation. Present trajectory measurement accuracy is limited by our incomplete knowledge of atmospheric refraction. The aim here is to find techniques for correction of these effects, and to define the magnitude of refraction effect in the measurement of position and velocity. Finally, AMR hopes to develop methods of correction and determining the magnitude of residual error after these techniques have been applied.

Another proposed study is of instrumentation for penetration and evaluation (ARIS vessels 5 and 6 will be designed to assist this project). Radar sensitivity, resolution, and appraisal of target characteristics will be investigated as a part of the study of acquisition methods. Pulse radars planned for use in the program will approach the limits of performance in antenna size, power consumption and radiation hazards. Associated data handling techniques also will be studied. ⌗

Space Work Increases at Test Centers

THREE AIR FORCE installations handle developmental testing of guidance, boosters and armament—the Missile Development Center at Holloman AFB, N.M., the Air Proving Ground Center at Eglin AFB, Fla., and Vandenberg AFB, Fla.

These functions represent only primary missions, for each now and in the future will support the Air Force military space programs in a steadily increasing and expanding effort.

• **Vandenberg AFB**—When VAFB was moved to SAC control, in January, 1958, an AFSC Field Office was set up to carry out the assigned mission of research and development. Development programs at that time, although well-advanced, included the *Thor* IRBM, *Atlas* ICBM, and the *Discoverer* program.

After several mission and name changes, the group was designated the 6595th Aerospace Test Wing in November, 1961. It is commanded by Col. Joseph J. Cody, Jr., a veteran of 13 years' AFSC experience and four years at VAFB.

In the overall VAFB scene, the base's primary mission is that of SAC's 1st Strategic Aerospace Division, commanded by Maj. Gen. Joseph J. Preston.

The 6595th Aerospace Test Wing now has over 500 personnel. It plays a critical part in all launches from VAFB —both in operational training and space programs. In its mission are included construction of all technical facilities, installation and checkout of technical equipment and demonstration of missile weapon systems upon completion. When operational, the missile systems are turned over to SAC, and technical assistance is provided by the Test Wing as required.

The 6595th's space mission involves field research and development for such programs as *Discoverer* and the *Atlas-Agena* satellite systems.

There are two deputies responsible to the Wing Commander: a Deputy for Ballistic Missile Systems and a Deputy for Space Systems.

The Deputy for Space Systems is responsible for field management of space programs assigned to the Wing. At present, these programs include *Discoverer, Atlas-Agena, Blue Scout* and Special Projects. Thirty-eight *Discoverers* have been launched from VAFB with 26 achieving orbit. During the same period, eight *Atlas-Agena* vehicles were launched. The *Blue Scout* program is expected to begin operations in the very near future.

Of the seven *Thor* launch pads at VAFB, one has been assigned exclusively for the use of *Thor-Agena* projects, excluding *Discoverer*, and another *Thor* complex has been given over to the *Thor-Agena-Discoverer* launchings. The single "off-beat" *Thor* pad is being converted to special NASA projects.

The Test Wing at VAFB is available and is usually called upon for support in projects other than those of a pure USAF nature—to aid in such NASA launches as may be made from VAFB. In this capacity, Test Wing personnel are usually those thoroughly familiar with the checkout and launch requirements of a particular booster system. They may also act in a general liaison capacity with whatever agency is sponsoring the program as far as payload is concerned. The Wing's primary interest, however, is the booster.

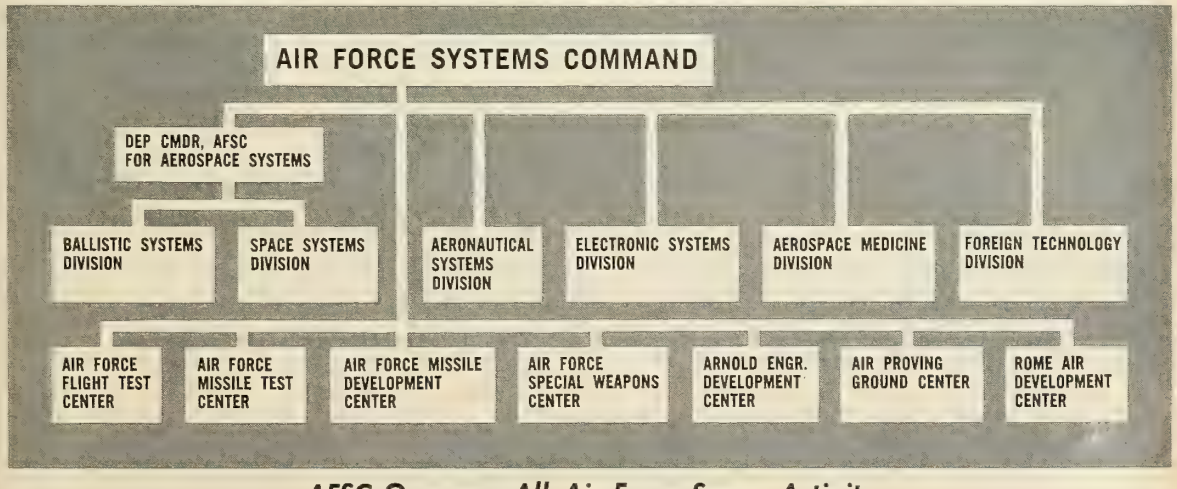
Test Wing capability must also be continually up-dated. Most of their experience stems from long-time launch experience of military weapon boosters. *Atlas* and *Thor* are two current examples of this. *Titan* booster experience will soon be added to the list.

The *Blue Scout* launches point up the "cooperative" feature of VAFB/PMR operation.

At the southernmost end of the 64,000-acre VAFB complex is the Naval Missile Facility, Point Arguello, Calif. This is where the *Blue Scout* launches have been and will be made. New probe-type launch facilities are near completion there.

The AF's Cambridge Research Laboratory has made several launches from

(continued on page 139)


AIR FORCE SYSTEMS COMMAND
DEP CMDR, AFSC FOR AEROSPACE SYSTEMS
BALLISTIC SYSTEMS DIVISION
SPACE SYSTEMS DIVISION
AERONAUTICAL SYSTEMS DIVISION
ELECTRONIC SYSTEMS DIVISION
AEROSPACE MEDICINE DIVISION
FOREIGN TECHNOLOGY DIVISION
AIR FORCE FLIGHT TEST CENTER
AIR FORCE MISSILE TEST CENTER
AIR FORCE MISSILE DEVELOPMENT CENTER
AIR FORCE SPECIAL WEAPONS CENTER
ARNOLD ENGR. DEVELOPMENT CENTER
AIR PROVING GROUND CENTER
ROME AIR DEVELOPMENT CENTER

AFSC Oversees All Air Force Space Activity

AIR FORCE SYSTEMS COMMAND, Andrews AFB, Md., headed by Lt. Gen. Bernard Schriever, administers all of the service's divisions and centers. Two divisions—Aerospace Medicine and Foreign Technology—were created in past year.

AEDC Adds New Space Test Facilities

Rocket test cells, hyperballistic range, and environmental chamber are under construction or planned; Center budget is rising

FULFILLING the environmental testing needs of the Air Force and other government agencies is the major objective of the Arnold Engineering Development Center.

To do this, AEDC and its operating contractor ARO, Inc., manage a vast, $300-million complex of wind tunnels, rocket test facilities and ballistic ranges —designed to test aerospace vehicles over the entire spectrum of flight (M/R, Aug. 14, '61).

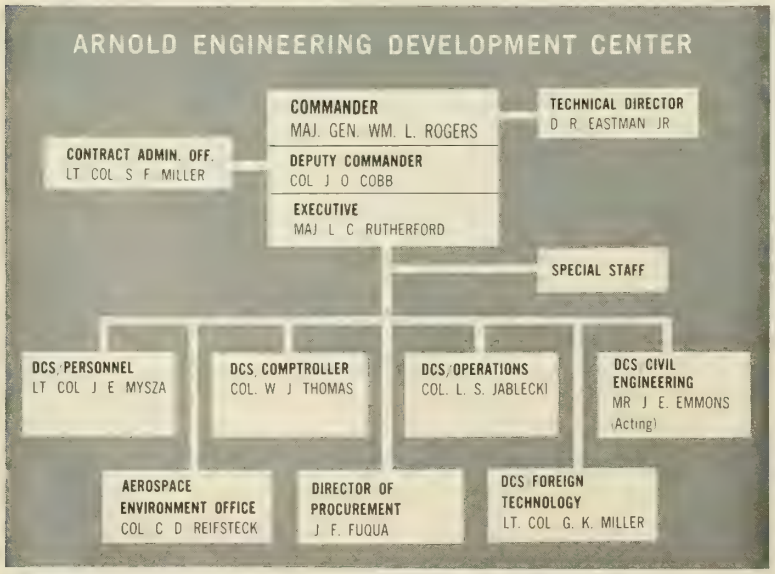
Complete performance of the AEDC mission, however, requires a constant updating of existing facilities and the construction of advanced, aerospace test chambers.

• **New facilities planned**—At present, four environmental test facilities are being added to the AEDC complex to more adequately meet the challenges of the space environment and the large rocket engine.

The first of these facilities—the J-2A ultra-high-altitude rocket test cell—recently completed shakedown tests. Capable of handling a full-scale *Agena* propulsion vehicle in its 32-ft.-long, 19-ft.-diameter test chamber, the cell can maintain a pressure of less than 3×10^{-6}mm. of mercury and a temperature of −320°F for several days.

Cryogenic pumping surfaces utilizing liquid nitrogen and gaseous helium, supplemented by oil diffusion pumps, are used to obtain the simulated 100-mile altitude. J2-A is the largest existing vacuum chamber in which chemical rockets can be test-fired under near space conditions.

Under construction is a 1000-ft. Hyperballistic Range—able to duplicate the Mach number, pressures and stagnation temperatures of advanced missiles and spacecraft during atmospheric re-entry. The 10-ft.-dia. ballistic range will be able to accommodate telemetry-instrumented projectiles up to 2½-in. in diameter at speeds of 25,000 fps or better.



AEDC engineers expect the new range to enable them to investigate wake geometry, microwave transmission and meteoric impact as well as re-entry dynamics.

Excavation for a Rocket Altitude Test Cell (J-4) has recently been completed, and the contractor is expected to begin pouring concrete into the more than 250 ft. deep hole soon. When it is completed the cell is expected to be able to handle rocket engines up to 1.5 million-lbs.-thrust at simulated altitudes in excess of 100,000 ft.

Although initially the J-4 will be able to handle only LOX/RP-fueled engines, it is expected that eventually it can be adapted for engines using liquid oxygen and liquid hydrogen.

The most sophisticated Chamber under development, however, is the Mark I Space Environmental Chamber. In its 35-ft.-diameter, 65-ft.-high clear test area, this ground test facility will have the capability to test full-scale satellite vehicles—such as *Discoverer, Advent* and *Satellite Interceptor*—under simulated space conditions.

The $17½-million facility will simulate the pressure, temperature, solar radiation, albedo, earth radiance at altitudes 300 miles above the earth—as well as the vibrational stresses on a space vehicle during launch.

Even more sophisticated space environmental chambers are under study to meet the anticipated aerospace requirements of the Air Force.

• **Dollars going up**—The annual operating budget of AEDC is presently a little over $37 million—85 to 90% goes to the operating contractor, ARO, Inc.

Officials at Arnold Center expect their budget to rise slowly as more facilities become operational.

Two main applied research areas account for most of the dollars spent by AEDC on research—developing criteria for large space simulation chambers and improving facilities already operational.

For example, in 1961, the Air Force let research studies for:

—Methods of transmitting data from a space vehicle undergoing test in a very-high-vacuum chamber to automatic data reduction equipment outside the chamber.

—Investigation of devices to accurately measure the density, composition temperature, radiation and other simulated environments of outer space.

—Research to determine the most practical and economical methods of simulating solar radiation in an aerospace ground test facility.

—Methods of ground-testing ion engines.

—New techniques for removing air from space environmental chambers to simulate the ultra-high-vacuum conditions of space.

• **Procurement areas outlined**—Most of the approximately 40,000 line-items stocked and maintained by ARO for the Air Force are procured on a fixed price basis involving award of 12-13,000 subcontracts annually. However, any item above $25,000 must be approved by the AF administrative contracting officer. In addition, special equipment such as machine tools and special pumps must be approved for purchase by the AF.

Of the 50-60 numbered AF contracts issued during any one year, approximately fifty percent are negotiated. The remaining fifty percent are awarded based on formal advertising procedures.

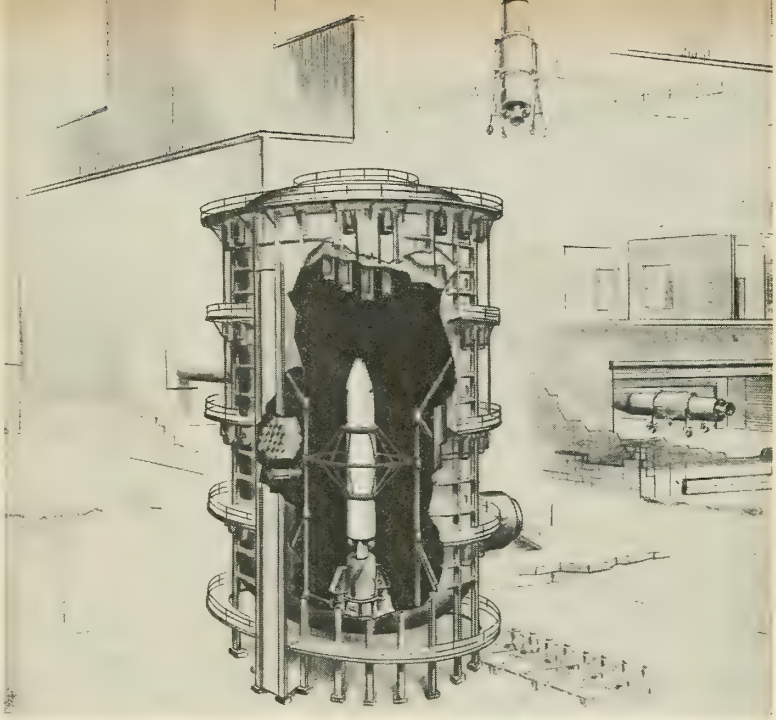
Using almost exclusively a cost-reimbursement type contract for research and development the AEDC procurement officers usually try to limit the number of bidders for a particular R&D procurement because of the low dollar value of the award as compared to the high cost, in both time and money, of evaluating a large number of proposals. Arnold officials consider the competition for both R&D and base procurement contracts now to be sufficient.

The small business participation in AEDC work, officials assert with no little pride, is approximately $4 million out of a total material procurement and maintenance budget of $10 million. This dollar total for small business represents some 70% of the items purchased.

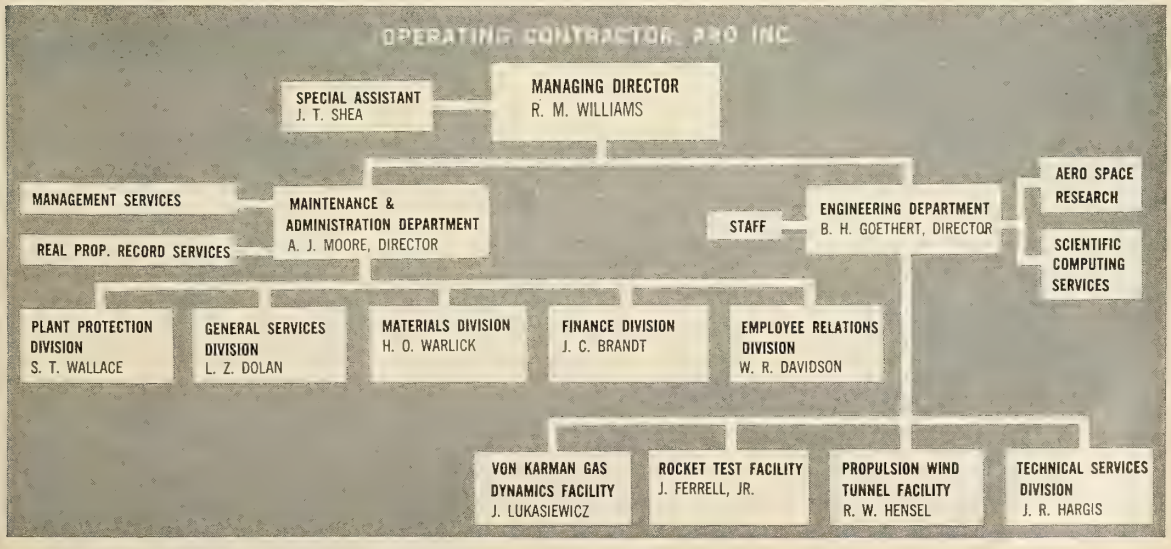
AEDC officials say industry is welcome to visit the Center at any time, to explain capabilities and to get on the bidders list. However, they stress that because of the extremely difficult and unique fabrication services required, their specifications are very rigid.

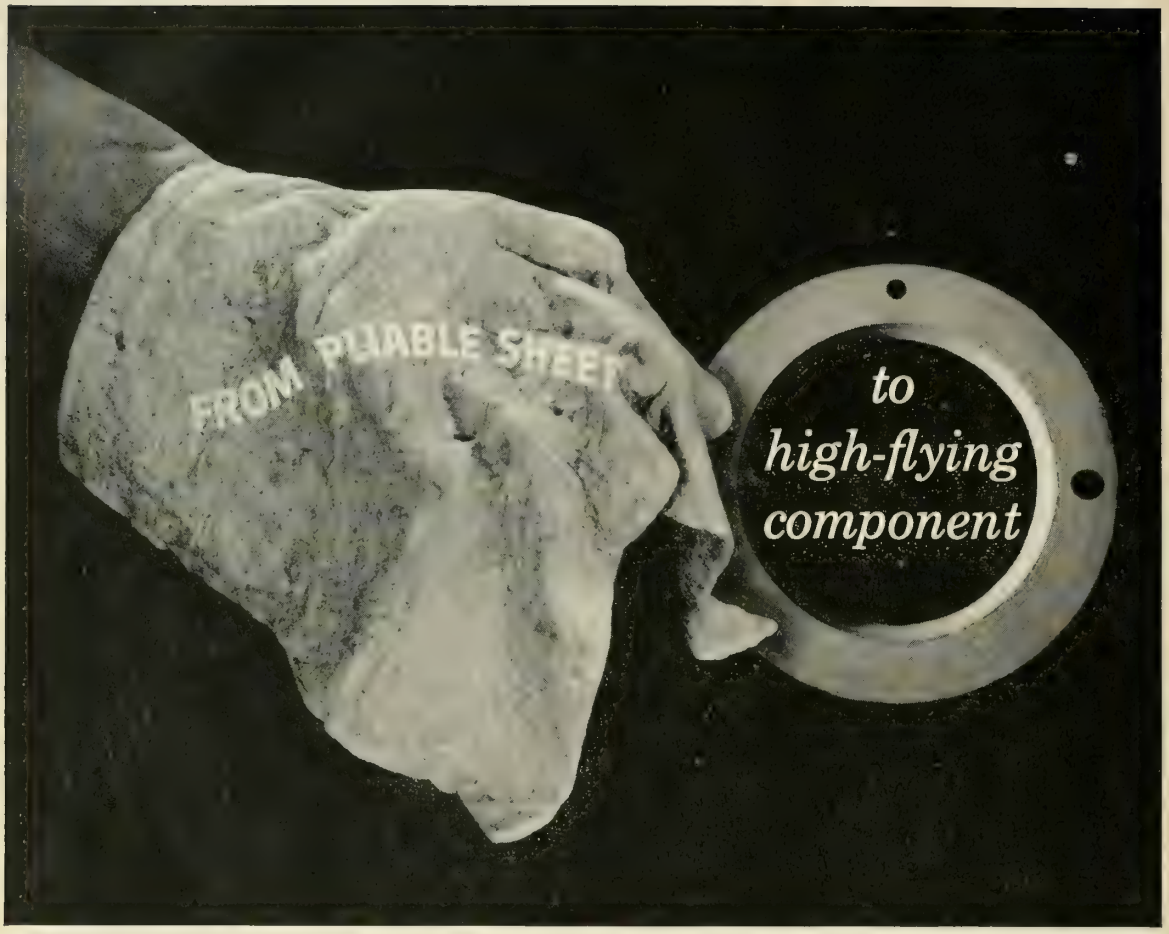
• **Major items procured**—In addition to architectural and engineering services for the expansion of facilities, AEDC spends most of its base procurement dollar in the following areas: high-speed cameras, magnetic core valves, instrumentation, transducers, ducting, steel, heat-treated metals and electrical equipment.

Liquid oxygen and nitrogen, propane and spare parts peculiar to the equipment are also bought from industry. ❖



ARTIST'S DRAWING of Arnold Center's Mark 1 Space Environment Chamber, which will be used to test full-scale satellite vehicles in simulated space conditions.





Parts molded of J-M Thermomat® meet the extreme service demands of the missile age

Here is a unique new molding compound in sheet form that offers many advantages in rocket and missile applications. Cured parts and components molded of J-M Thermomat—such as the collar you see here—have already proved they can meet the most extreme service demands.

Because these parts withstand high temperatures, offer maximum resistance to ablation and erosion... they are currently being used as an erosive flame shield for protecting critical guidance and stabilizing mechanisms on operational missiles.

Thermomat's high strength-to-weight ratio is another important advantage, permitting rocket weight to be reduced and fuel capacity increased. Thermomat parts also have a high modulus of elasticity.

In sheet form, this non-woven asbestos-phenolic molding compound is unusually conformable and pliable, making assembly quicker and easier. Molders like the way joints and seams work together as readily as putty . . . and the fact that one man can handle lay-up, saving hours of time.

Non-fillouts are at an absolute minimum, even on complex configurations. Asbestos fibers are free-flowing during molding, resulting in a uniformly reinforced part. This versatile product lends itself to both low and high press molding cycles, thus keeping inventory and waste to a minimum. Any machining of cured Thermomat parts to precision tolerances can be easily accomplished with standard metal-working equipment.

Thermomat is supplied in sheets 14" wide . . . approximately 12' long ...and 1/16" thick. Thermomat in other dimensions may be supplied on request. Molders are invited to write for Technical Bulletin TX-10A and a generous free sample in order to try this remarkable molding material for themselves. Write Johns-Manville, Box 359, New York 16, N.Y. In Canada: Port Credit, Ont.

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Edwards Looms Large in Dyna-Soar

Flight Test Center has outstanding qualifications as 'spaceport'; major concern is range receiving equipment

EDWARDS AIR FORCE BASE, home of the Air Force Flight Test Center, will move strongly into the space business in the *Dyna-Soar* program—and could easily wind up as "Spaceport, Terminus—USA" for manned and unmanned vehicles.

The Center has a "high" range, extending from Edwards northeast to Wendover, Utah, approximately 362 miles. The range facilities are being updated—particularly telemetry installations. These last are being modified for a more detailed readout of operations in real time—a must for *Dyna-Soar* studies.

The AFFTC's Space Positioning Range handles vehicles within an area 125 mi. long and 100 mi. wide, with altitudes over 100 mi. This capability is being increased through the modernization program.

Space positioning operations also have satellite tracking stations. Long-range optical tracking systems have been installed. The modernization program has been funded through normal budgetary channels and all are part of AFFTC's long-range plans.

The surrounding area bolsters Edward's possibilities as a terminal point for space missions. Directly to the north lies the Naval Ordnance Test Station (NOTS), China Lake, Calif.—another unit with long-term tracking and data-acquisition experience and equipment.

The huge Pacific Missile Range complex is located to the west of Edwards—the Naval Missile Facility, Point Arguello and Vandenberg AFB—installations with well-known tracking and instrumentation capabilities.

Northwest of Edwards, about 400 mi. away, sits the well-publicized Air Force Satellite Test Wing at Sunnyvale, Calif.—more tracking and data acquisition ability.

This places Edwards at the hub of a completely instrumentated and extremely large geographical area.

In addition to the relatively unpopulated area immediately surrounding Edwards, there are many auxiliary sites capable of mobile instrumentation. The broad expanse of the alkali lakes in the California desert—and the number of usable lakes—make the area a "natural."

• **More apples**—For land recovery of vehicles from "conventional" orbits, Edwards is a logical expansion of PMR. But the Air Force is looking at other sites. The Air Force Missile Test Center at Holloman AFB is a possibility; Holloman has a well-proven tracking and instrumentation ability, but its scope and the land area involved are somewhat smaller than Edwards.

In the *Dyna-Soar* program, over two dozen drop tests will be made at the AFFTC high range. But Edwards is still vague about its exact role in the manned-glide, re-entry concept.

The Technical Support Directorate (TSD) will bear the brunt of the operation. They are responsible for the air-launch portion of the development program, and some early data reduction is involved here. In addition, TSD will probably be called upon to determine the parameters that should be measured during full-scale orbital flight. This, however, is not entirely their domain.

Even in its early testing phases on the *Dyna-Soar* launch, Edwards will have a great deal of instrumentation work. Most of the data will be recorded—both on the *Dyna-Soar* and telemetered to ground stations.

This will be prime data, not every detail during the mission profile. It is believed that this will hold true even for the orbital shot. During the development tests, Edwards will do most of the "quick look" data processing, leaving the detailed processing to other AF centers or NASA.

One of the major concerns at Edwards then is equipment development—range receiving equipment—to handle the bandwidth of expected data. TSD personnel say they expect about 750 data points per *Dyna-Soar* mission!

• **Real time rough**—A primary area of instrumentation study is the degree of accuracy required for *Dyna-Soar* and other manned space systems. The biggest single problem within this specialty is real time. Air Force and industry experts point to this as the single most critical problem in *Dyna-Soar* and many other projects of this type. Concern is widespread.

As far as telemetry for the air launch portion is concerned, TSD believes this can be handled with the usual amount of time-sharing on the channels. TSD is modifying its PCM system to the *Dyna-Soar* format.

It may even be necessary to develop a new symbol code for *Dyna-Soar* in order to handle the amount of data. In this area, Edwards TSD will have to modify its ground stations. This can probably be done in-house. A more advanced digital printer and radar plotting boards will be needed. TSD would like a "workable and realistic" 3-D radar—and thinks this is feasible.

Unless a program demands a specific piece of equipment unique to the particular project—and this equipment is funded separately from the AFFTC budget—TSD limits purchases to systems that tend to update the center as a whole.

TSD stresses the need for standardization in global range operations. *Dyna-Soar* will probably use all available facilities, and all systems must meet data processing equipment requirements. All *Dyna-Soar* and range instrumentation must match.

TSD has an active program in transducers directly applicable to space systems. Some tests of the equipment have been made in *X-15* flights, but the program is still going. TSD believes much more work is necessary in determining what areas have to be transduced for space missions—especially new areas. How this is to be done—and to what accuracy—are also factors to be considered.

In the instrumentation area, TSD works very closely with the *Dyna-Soar* Instrumentation Development Team.

Increased technical responsibilities in the field of range measurements have required the creation of new positions at the Lincoln Laboratory. We invite inquiries from senior members of the scientific community interested in participating with us in solving problems of the greatest urgency in the defense of the nation.

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This group reports directly to the Systems Project Office at ASD. IDT meets every three to four months, and consists of representatives from NASA, AF Centers, PMR, and Boeing. Eventually RCA and Martin will be added to the list.

In the overall instrumentation area, AFFTC is represented on the Interrange Instrumentation Group (IRIG)—a group which aims at standardizing as many range instrumentation functions and systems as possible for all ranges.

Edwards is also represented on the Range Commander's Conference, a high-level group attempting to standardize range operations. This group also tries to determine how each range ties in specifically with the national range system for each project.

Edwards, then, is subservient in *Dyna-Soar* to the "lead" or launching range—in this case, the Atlantic Missile Range. AMR is charged with working out the master plan for the project and coordinating this plan with other ranges. Edwards can, however, coordinate plans on a specific project with that project's SPO. Any other range can do likewise; support can be either direct or indirect.

Across Rogers Dry Lake from Edwards lies the 6953d Test Group (Development), a unit under the command of SSD. The Group concerns itself primarily with chemical and nuclear propulsion—and applied research levels in both (see Propulsion, page 64). Unsolicited proposals from industry to this organization are handled by Lt. Col. H. W. Robbins, Chief of Plans and Operations.

Outside of its in-house work for SSD, the Group provides engineering support to Aerospace Systems Division for *Dyna-Soar* and other projects. About 20% of its effort is for the Ballistic Systems Division.

The in-house work is targeted at getting results as rapidly as possible. The Group explores work that cannot be done by industry for various reasons. In addition, this in-house approach to some major programs enables the Air Force to determine feasibility and other project characteristics faster than a contract could be drawn up and let—test results from some tests can be available for evaluation within 90 days.

Efforts are made to keep ahead of weapons systems thinking by at least three years, and goals of the Group are laid out on a five-year basis.

The Group has about 200 contracts with over 65 major firms and other work with lower tier contractors. The unit is also investigating military applications of nuclear propulsion. They have explored the field as to reasonable size, performance, cost and time considerations. In addition, some work is in progress on non-nuclear components for such vehicles. ⌗

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OAR Upgraded, Up-funded for Research

Organization's relatively small support of industry has led many firms into R&D field; original proposals encouraged

FORMATION OF the Office of Aerospace Research (OAR) almost a year ago as a separate command responsible directly to Headquarters, USAF, marked formal recognition of the increased rank of research in the Air Force structure—with a corresponding increase in research money.

For the next fiscal year, OAR expects that its current fiscal year budget of $50.0 million for contracted basic research will be increased about 10% and its applied research budget of $12.1 million raised by a similar percentage.

(OAR is responsible for planning, programing and managing USAF's basic research program and that portion of the applied research program assigned to it.)

The additional money will be used to cut into a growing backlog of urgent research studies awaiting contracts and to absorb the increased cost of doing research.

• **OAR basic research** — Only a minor fraction of OAR's basic-research money goes to industry, most of it going to universities. Nevertheless, OAR's backing—though relatively small—has given many industrial concerns the impetus they needed to participate in basic research, subsequently leading to research and development projects.

About 80% of OAR's basic-research work is said to be space-oriented although it is admitted that the nature of basic research leaves its orientation open to many interpretations.

OAR supports research that holds promise of contributing to the success of the USAF mission. In turn the mission gives rise to a USAF long-range plan, which perhaps might call for a manned spacecraft to be developed within the next ten years.

Such a vehicle would pose requirements in broad basic-research areas such as propulsion, materials, electronics, geophysics, life sciences and aero-mechanics; and perhaps in applied

DR. MILLSAPS
OAR Chief Scientist

MAJ. GEN. HOOKS
OAR Commander

research areas such as aerospace environment, weapon effects and nuclear applications. These are all areas of OAR interest.

Taken out of the context of an Air Force project, the chief work of OAR is in scientific disciplines such as mathematics, physics, chemistry, psychology, biology, astronomy and meteorology.

OAR is divided into four organizations, each conducting or sponsoring research and serving as an interface between USAF and the scientific community: Air Force Office of Scientific Research (AFOSR), Air Force Cambridge Research Laboratories (AFCRL), Aeronautical Research Laboratory (ARL), and the European Office of OAR (EOAR).

• **Mission of AFOSR**—AFOSR is the only USAF agency that has the primary mission of encouraging basic research solely by contract. It does this through grants and contracts awarded on the basis of unsolicited research proposals, which are sought by scientists in universities, nonprofit institutions and industry.

AFOSR's current budget is $30.6 million, which is spent on more than 1200 grants and contracts. These are held by investigators working in most of the free and scientifically advanced countries in the world. About 80% of OSR's money goes to universities and the rest to industry.

Since universities are able to perform research cheaper than industry—for tax and endowment reasons among others—and because AFOSR has funds limited for the job it has to do, there is no chance that industry's share of the AFOSR budget will increase perceptively in the near future. However, industry has made some headway: when AFOSR was formed, industry received almost none of the organization's money.

• **The grant program** — AFOSR'S grant program was started in fiscal year 1961 and is intended to cut out much of the red tape surrounding normal contracting procedures. Available only to scientists working for nonprofit organizations, AFOSR grants are made for periods up to five years. Usually the grantee is required to furnish only a final technical report to AFOSR, which may be a reprint of his research as it appeared in a scholarly journal.

AFOSR is encouraging all nonprofits to accept grants, which are absorbing about half of AFOSR's budget. AFOSR affirms that its primary concern is that "granted funds be used in a manner which will make a maximum contribution to the progress of science—and it is expected that grantees and investigators will also direct their efforts to this end."

• **Industry and AFOSR** — An AFOSR spokesman pointed out that the prevailing way for industry to do business with AFOSR—not OAR as a whole—is on a cost-sharing basis. He emphasized several times that this means is "always voluntary" but in many instances necessary in order to put industry in a more competitive position.

As a sidelight, the spokesman observed that there have been recent instances of several universities beginning to price themselves out of the market. "This was virtually unheard of three years ago" he said, "but now I see the camel's nose poking into our tent."

Although AFOSR much prefers putting its money into studies instead of

brick and mortar, it will on occasion sponsor a unique research plant: the National Magnetic Laboratory at the Massachusetts Institute of Technology where a ¼-million-gauss magnet facility is being established for research on the properties of solids in very intense external magnetic fields.

• **Mission of AFCRL** — The Air Force Cambridge Research Laboratories (AFCRL) comprise USAF's leading center for basic and applied research in electronics and geophysics. For this work, AFCRL has been spending about $50 million each year to pay for approximately 700 contracts held by companies and universities.

Only part of AFCRL's money comes from OAR: about $9.3 million earmarked for basic research during fiscal year 1962, and $12.1 million for applied research. The rest of the money originates from other sources within the Air Force and Department of Defense. The funds are usually used for direct support of research carried out by AFCRL scientists or for sponsoring research that can be processed through AFCRL facilities.

AFCRL's stated mission "is to anticipate what techniques and equipment will be needed by the Air Force five to twenty years in the future."

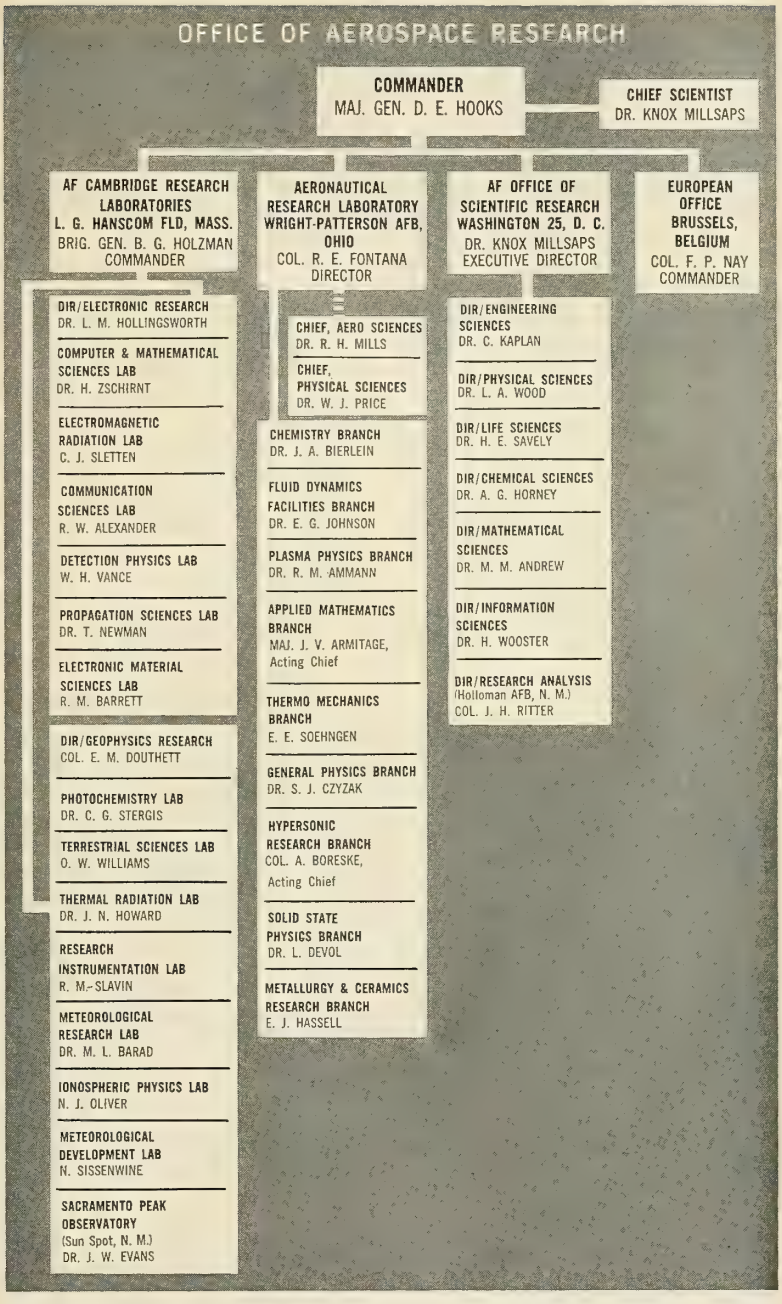
Although applied research is necessarily closer to an ultimate mission than basic research, still there is no easy way to pick out how much applied research will be useful for a space mission.

Good applied research tries to develop a technology rather than a piece of hardware. For this reason, AFCRL is concerned with solving general technical problems and correspondingly divides its efforts:

—*Electronic materials.* Much of the electronic materials work at AFCRL falls under the familiar heading of solid-state physics: synthesis and purification of materials, growth and analysis of single crystals, fabrication of experimental solid-state devices, study of the physical chemistry of materials and the effects of radiation damage.

—*Upper atmosphere and space.* AFCRL is looking into the characteristics of the upper atmosphere to learn its composition, density, electrical structure and temperature as a function of altitude and seasonal variations. Moreover, the work includes micrometeorite measurements together with studies of the effects of the particles on communications and space vehicles.

Direct probings of the atmosphere are the chief means that AFCRL uses to get its data. Each year more than 40 research rockets and satellites carry AFCRL instruments into the upper atmosphere and space. (A $12-million OAR program monitored at Headquarters, OAR, furnishes probe vehicles for USAF use.)



—*Solar-terrestrial relationships.* AFCRL says that "our first problem is to determine what types of solar activity produce geophysical responses. What makes one flare knock out radio communications over a whole hemisphere while another has little or no influence?" Basic studies of the sun and its radiations are carried out at the Sacramento Peak Observatory in New Mexico where AFCRL operates one of the world's leading laboratories for observing solar phenomena.

—*Plasma physics.* "We are particularly interested in the plasma sheath which envelops the nose cone of a missile (or a spacecraft) during re-entry." For communications purposes, AFCRL wants to learn the best radio frequencies and power to be used to penetrate the sheath. The agency is also concerned with using plasmas for space-vehicle propulsion and for certain electronic components.

—*EM wave phenomena.* AFCRL scientists are backing studies in antenna design, which call for a knowledge of

(Continued on page 141)

BuWeps Spends Most Navy Dollars

Bulk of space funding—due to top $50 million in FY '63—goes to industry; goal 'better job on earth'

THE MAJOR SHARE of Navy's money for space, expected to significantly exceed $50 million in the next fiscal year, goes to the Bureau of Naval Weapons.

BuWeps is responsible for the payload integration and launch-vehicle engineering for all Navy astronautics programs.

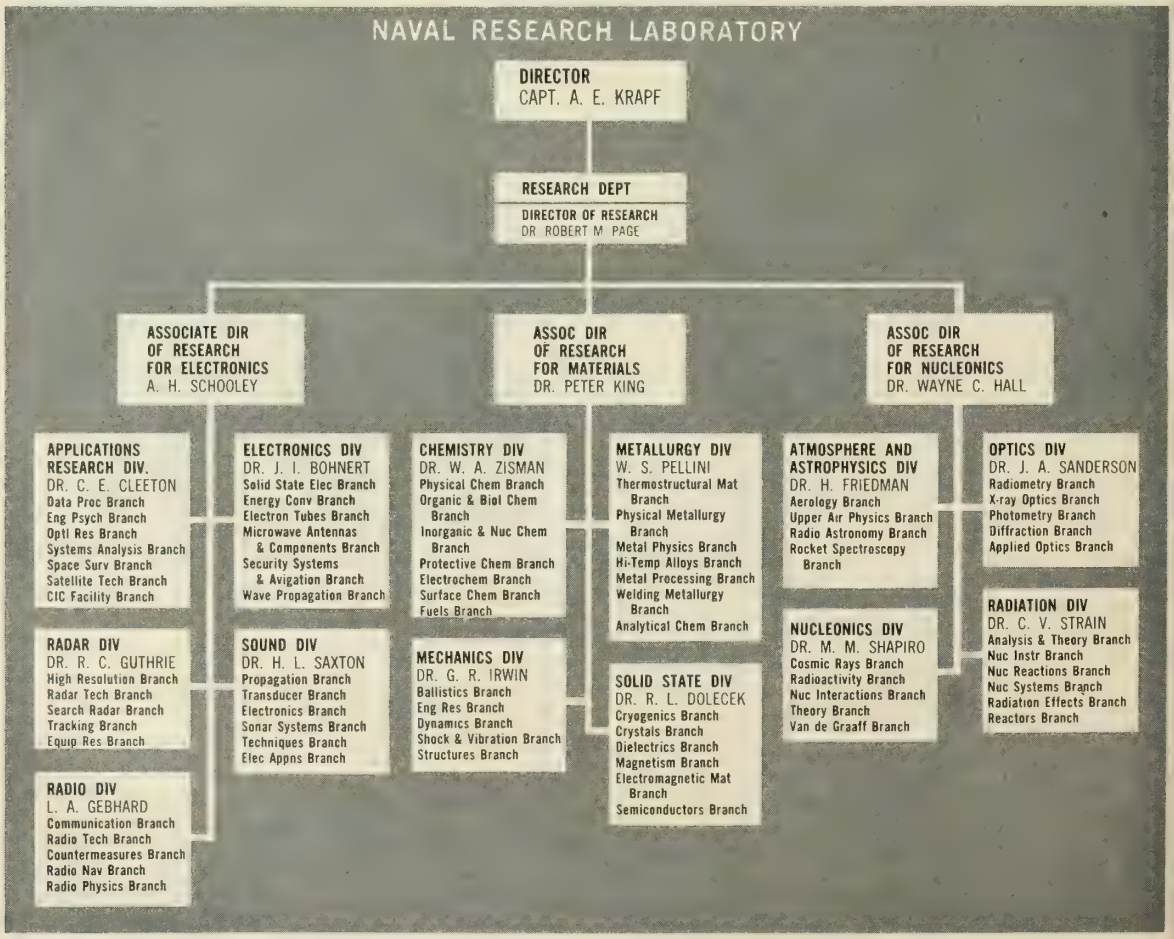
To carry out its mission, BuWeps contracts with its own laboratories, with the other services, and with industry for appropriate research and development work. For its launch vehicles, BuWeps goes to NASA to buy *Scouts* and to the Air Force for *Thor Ablestars.*

All BuWeps RDT&E for space is done in its Astronautics Division, headed by Captain R. F. Freitag. This is an operating office responsible for the management and technical direction of most of the Navy's space activities. This is also industry's touchstone for contract information, particularly for the larger concerns. Smaller concerns are advised to make direct contact with the Navy's operating laboratories.

Reporting to the Assistant Chief for Program Management, the office of the Director of Astronautics Programs, headed by Captain H. D. Helfrich, Jr., is responsible for the budget, planning, deployment and coordination of BuWeps space activities. In general, however, this is not the office for industry to contact for R&D contracts.

• **Money for industry**—Far more than half the BuWeps budget for R&D in astronautics went into outside contracts in Fiscal Year 1962, according to Capt. Freitag. The remainder went into in-house work, most of it to Naval laboratories which, in turn, spent part of the money with industry.

In carrying out its astronautics programs, BuWeps works chiefly with



seven facilities: Naval Ordnance Test Station, China Lake, Calif.; Naval Research Laboratory, Washington, D.C.; Naval Ordnance Laboratory, White Oak, Md.; Navy Electronics Laboratory, San Diego; Naval Weapons Laboratory, Dahlgren, Va.; Navy Missile Center, Pt. Mugu, Calif.; and the Applied Physics Laboratory of the Johns Hopkins University.

"Our philosophy in Navy astronautics is to keep things real simple, make them low-cost, and get the systems into operation as soon as possible," says Freitag. He added that "the Navy's main objective is to do a better job on earth from space—such as devising better communications and navigation systems—and deferring work on operations *in* space until a later date."

BuWeps' major astronautics project is *Transit,* the navigational satellite system scheduled to be placed in orbit late this year. The Bureau is also deeply involved in data-processing for the meteorological satellite program *Tiros,* and is buying the read-out equipment to be placed aboard ships.

The ability to forecast local weather conditions is so vital to the fleet that BuWeps is supporting Project *Hugo,* a program in which ships at sea will have their own supply of vertical probes. These probes are expected to serve the same meteorological purpose as *Tiros* and will be particularly useful when the weather satellites are not in view.

Other BuWeps astronautics projects include *Spasur,* the Navy-operated electronic fence for discovering orbiting satellites; *Anna,* a classified geodetic satellite project in which the Applied Physics Laboratory holds the prime contract; the *Composite* satellite, five payloads integrated into a single payload by NRL, and launched by a *Thor Able-star.*

BuWeps is also heavily involved in astronaut recovery operations—15,000 Navy personnel were assisting in the Glenn flight; in aeromedical research through a centrifuge at the Naval Air Development Center, Johnsville, Pa.; and through a Disorientation Facility at the Naval Air Station, Pensacola, Fla.

• **Research in astronautics** — The Office of Naval Research (ONR) supports a broad band of basic and applied research having space ramifications, most of the basic work being carried out under contract with universities, and practically all the applied research in-house at NRL.

Supporting ONR's contract research program is a $73-million budget for Fiscal 1962, a slight increase over the previous year's figure of $71 million. It is extremely difficult, however, to tell exactly how much of this money will have eventual space applications—it is hard to forecast the end-product of research, particularly basic research.

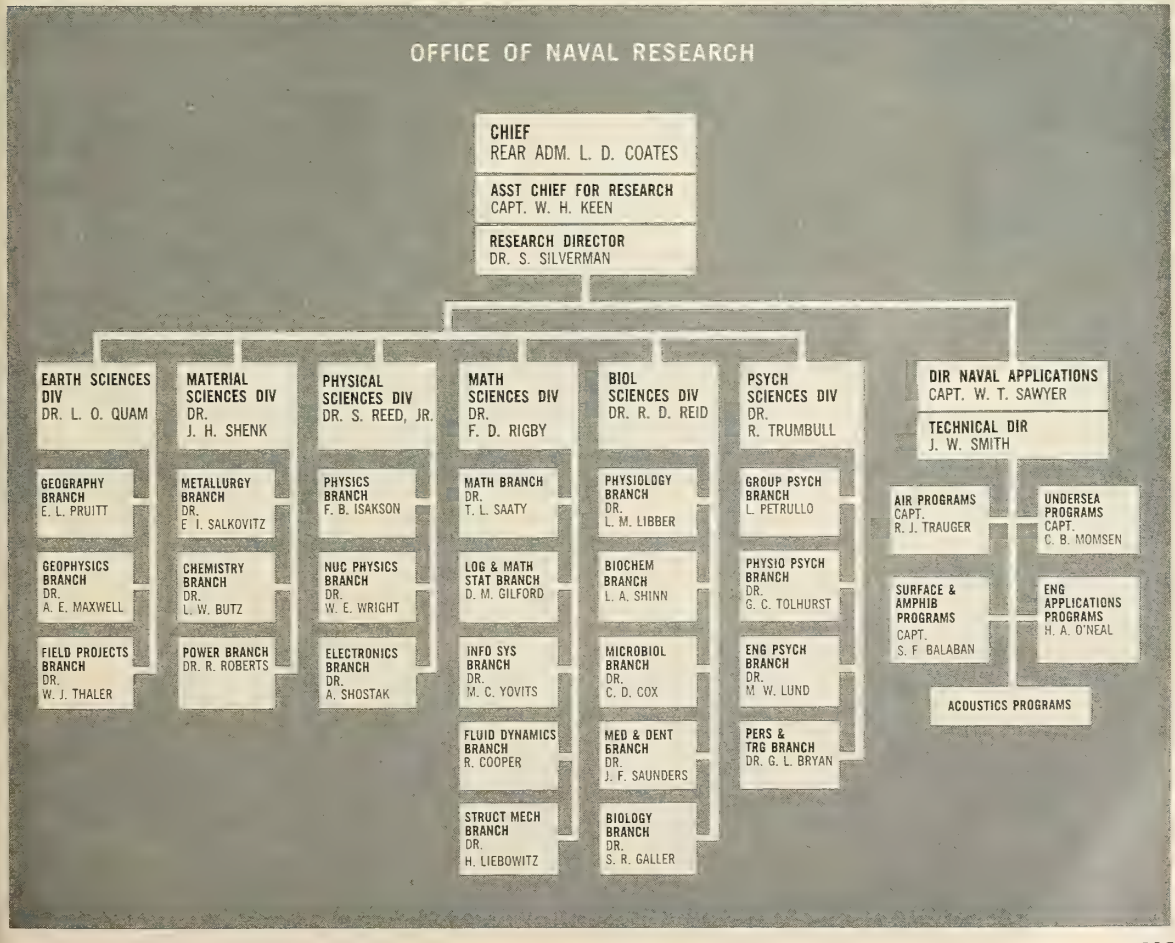
Much of ONR's research money is broken down into relatively small basic research contracts, 90% of them with non-profit organizations.

Typical of ONR-supported basic research in astronautics is an investigation of the radiations in space by Dr. James Van Allen of the State University of Iowa. ONR has been supporting Van Allen in this work since 1952.

Included in this program is the *Injun* satellite, designed to help make detailed measurements of the radiation belts and to learn how they affect the creation of aurorae, especially the Northern Lights.

Injun I has been in orbit for nearly

(Continued on page 140)



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PMR Expects to Top Cape in Major Launches

Range will need 'more of everything' from industry to meet soaring work load; FY '63 funding goal $114 million

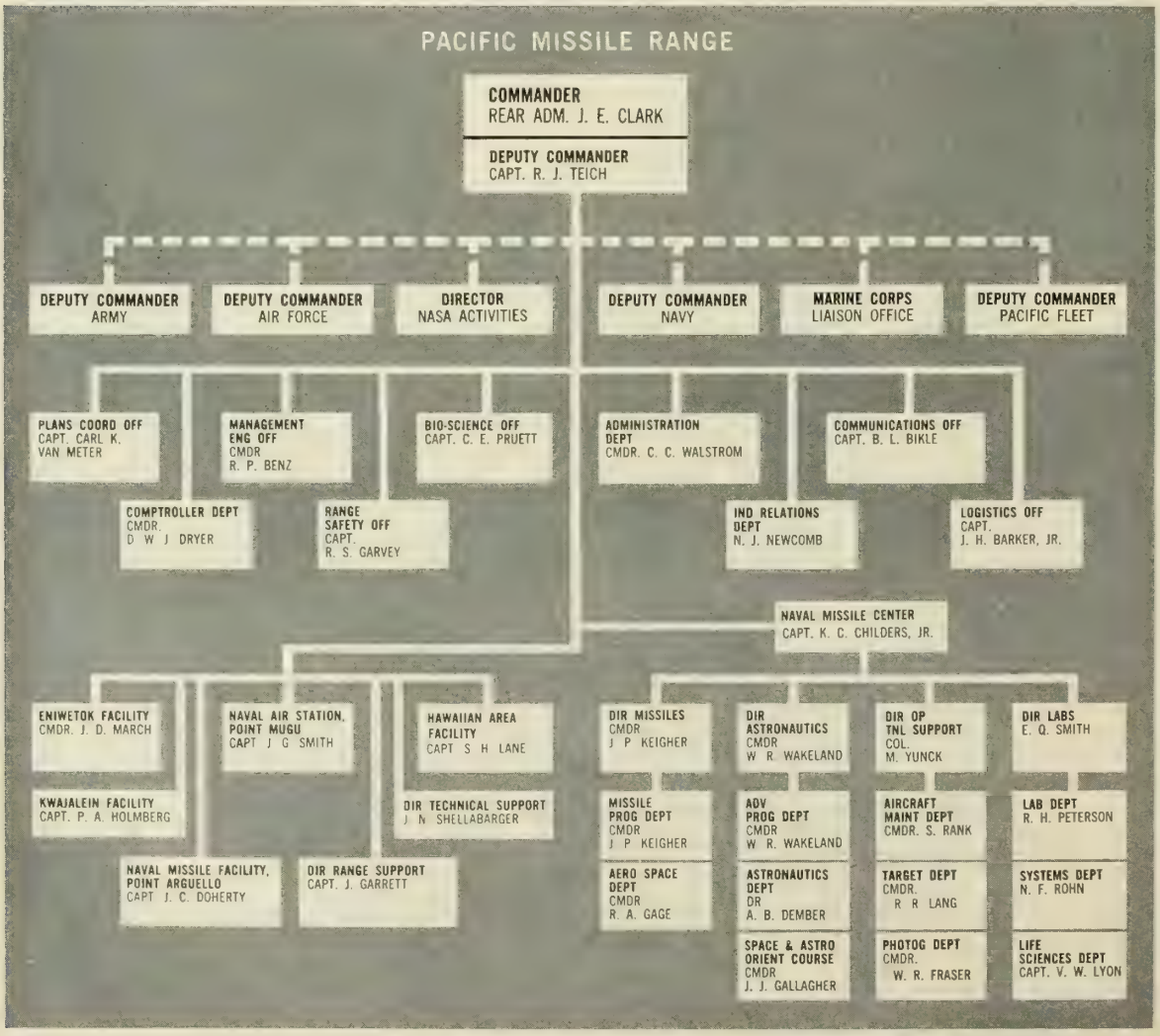
PLANNING FOR the Pacific Missile Range is based on the expectation that within one or two years the number of major vehicle launchings from the West Coast will exceed that of Cape Canaveral.

But this is only part of what the PMR commander, Rear Adm. John E. Clark, has in mind when he says that the range's work load is "increasing astronomically" as the national space effort gains momentum.

PMR's work also is increasing with the growing number of satellite launches from the Atlantic Missile Range which utilize PMR tracking, data collection and data reduction facilities. *Mercury* orbital flights are a recent example.

Stan Radom, PMR deputy director of range support, explains why major West Coast launchings are expected to exceed those from AMR within the next two years:

—NASA will begin space launches from PMR this year, with *Thor-Agena*,



Atlas-Agena and *Scout* firings scheduled. Modification of a pad at Vandenberg AFB for NASA use is due to be completed this month. First of NASA's polar-orbiting satellites will be *Echo II*.

—Personnel from each Air Force operational missile site in the country will be firing a missile from Vandenberg in each quarter of the year.

—A third factor that already has added to the number of PMR launches is the *Nike-Zeus* program, which includes firings of both the A-ICBM and *Atlas* missiles.

In addition to this increasing activity, PMR planners see the need for building a new global network for tracking military space vehicles. Many *Mercury* tracking sites, for example, cannot be used because they are located in foreign territory under agreement that they can be used for civilian space programs only.

"A military man cannot even visit the *Mercury* site in Mexico," one spokesman said. He added that this problem had caused "considerable delay in getting *Advent* started." A government-to-government agreement must be made with Australia for use of two sites in Australian trust territory in the *Advent* program.

The Navy, because of its relativly small role in the missile/space program, will not add greatly to the number of major PMR launches in the near future, although it is progressing with work on Project *Hydra*, the sea-launch program in which more than 60 launches have been conducted. Officers in charge of the *Hydra* program at the Naval Missile Center, near PMR headquarters at Point Mugu, Calif., have been trying to interest NASA in the sea-launch concept. If they succeed, this would add to PMR launches.

• **Swelling requirements**—What all this means to industry is that PMR will be needing "more of everything"—launch facilities, land and shipboard instrumentation for tracking, communications, data reduction, frequency interference control, and equipment and materials for photographic services, recovery services, ground and flight safety, weather services, maintenance and repair of facilities, and research, development, test and evaluation.

PMR has always stressed mobility of its equipment. "We differ from other ranges in this respect," a spokesman said. "We've always been heavy on seagoing equipment." The range currently has seven range ships, and plans to add another by the end of 1963. For its role in the *Dyna-Soar* program, PMR believes it will have to outfit four or five ships, a program which could run as high as $50 million.

"One thing we need from industry is more company R&D, more advanced thinking, inventions," the range planners told M/R. "Industry can be assured that with the programs in view and the way things are going, if it comes up with something good it has got something it can sell."

Radom listed these PMR needs:

—"PMR will have continuing contractor assistance in studying problems associated with launching missiles using toxic fuels. We need to know the degree of hazard associated with launching of missiles which use nuclear power supplies in the payloads, and missiles and space boosters using nuclear engines.

— "We are greatly interested in studies to determine optimum design for multipurpose and multiple-vehicle launch pads, because as the amount of real estate suitable for polar launchings decreases, we have to utilize remaining real estate as efficiently as possible.

—"We have a greatly increased launch rate. There has become an acute condition in supporting major vehicle launches because there are seven systems tests supported by the PMR and an average of three countdowns prior to each major vehicle launching. This creates a problem in management of radio frequencies and in scheduling and use of range safety instrumentation. PMR is endeavoring to equip the Point Arguello area with sufficient equipment. Scheduling procedures will be established to enable a multiple countdown capability through efficient utilization of both Point Arguello and Vandenberg support facilities. We are shooting for capability to launch dissimilar vehicles from different launch complexes within 30 minutes of each other."

R. ADM. J. E. CLARK—*PMR's work load is "increasing astronomically."*

• **Telemetry, other problems**—Kenneth I. Lichti, head of the Range Analysis and Planning division, gave this rundown on PMR needs:

"R&D support is seen as necessary to solve many specific problems facing the PMR, including: (1) provision of new telemetry frequencies, (2) acquisition and tracking of short wavelength signals, (3) calibration of highly precise tracking instrumentation and verification of satisfactory performance, (4) provision of adequate range safety, (5) development of an underwater range, and (6) measurement of new environmental parameters."

Lichti discussed telemetry and the "major problems foreseen as a result of the necessity to provide hardware, systems and techniques for operation in portions of the RF spectrum not now used for telemetry."

Noting that at present the greatest telemetry activity is in the VHF band, forty-four 500 kc assignments distributed from 225 to 260 mc, Lichti said it is expected that these frequencies must be abandoned for telemetry purposes by 1970.

"Plans have been to convert operation primarily to "S"-Band—2200 to 2300 mc. For a number of reasons, however, this conversion will not occur as previously planned; radical changes in the telemetry frequency assignment pattern can be expected.

"The 2200-to-2300-mc telemetry band still exists and will continue to exist. This band, however, has an extremely broad use allocation and is not protected for missile testing and space vehicle telemetry usage. Furthermore, the required abandonment of the VHF region coupled with an expected increase in telemetry utilization indicates that insufficient room at "S"-Band would soon exist. As a result, action was taken . . . to obtain another 100 mc allocation between 1435 and 1535 mc. This allocation provided 50 mc primarily for aircraft flight testing and 50 mc, from 1485 to 1535 mc, for missile and space vehicle telemetry."

Lichti said that because of the developing frequency utilization patterns, the ranges are beginning to bring pressure for development and utilization of the 1485-1535-mc area for telemetry. To accommodate developments already begun and the possibility for limited utilization of "S"-Band, it is expected that hardware procurements previously planned for "S"-Band will now require operation at both "S"-Band and in the 1500-mc region, with a minimum of operational change required at ground receiving stations to shift between the two.

Lichti said it is conceivable that current trends in utilization will result in saturation of the 1500-mc area long before abandonment of the VHF area is forced in 1970. "The long-range problem foreseen, then, is the develop-

ment of a telemetry state-of-the-art in another portion of the spectrum, a portion not yet identified but most probably considerably higher in frequency than 'S'-Band."

• **More money sought**—Adm. Clark points out that while the PMR work load curve is "going straight up, the budget is not going up proportionately."

John F. Malbon, PMR deputy comptroller, said planners currently are shooting for $114 million in Navy funds for the range in Fiscal 1963, compared with about $110 million this year.

Of the $114-million budget, some $110 million will come directly from BuWeps and is earmarked for RDT&E.

In addition to the Navy budget, PMR can count on another $3-5 million from other agencies to support their requirements on the range. These include NASA, Army, Air Force, AEC, the U.S. Weather Bureau and others.

Malbon estimated this partial breakdown for 1963 spending: $24 million for civil service labor and overhead; $6 million for consumable materials, mainly materials drawn from the naval supply system; $27-28 million for equipment procurement. Most of the latter will be spent with commercial suppliers for everything from commonplace shop equipment to radars and computing machines. Comparable figures in the current fiscal year are $23 million, $5.1 million, and $17 million—meaning a big increase in equipment procurement next year.

Contractual operations are expected to run to $57 million in 1963, compared with a current figure of $44 million.

The Naval Missile Center at Point Mugu has its own budget, which stands at $20 million for Fiscal 1962. Of this money, missiles and related aircraft systems claim the biggest chunk—$14,750,000—with $2 million going to target test and operation, $2 million to associated support, $1 million to astronautics and advanced programs, and $250,000 for foundational research.

• **Industry's openings** — The Navy itself has few military space systems. As Dr. Alexis B. Dember, head of the Astronautics department at NMC says, "the last two years have been a very rough time for astronautics."

The main business Dember sees for industry is in two areas:

—Development of sea-launched missiles. "We haven't gotten deep into the hardware stage yet, but when we do, we'll need more industry help."

—"As we get into system development, we will need industry help in payloads, payload orientation control and related ground instrumentation."

(Continued on page 142)

NOTS Work Yields Payoffs in Space Effort

THE NAVAL ORDNANCE Test Station at China Lake, Calif., is primarily just what its name implies.

But military planning for space has had a considerable impact on NOTS—although its primary mission remains the development of new and better Navy weapons and the conduct of research related to weapons.

With over 4000 civilian employees and approximately 1300 military personnel, NOTS is the Navy's largest ordnance research, development, testing and production engineering center—all in one organization.

One NOTS development with a payoff in space programs is the *Sidewinder* infrared-guided air-to-air missile.

Sidewinder infrared experience at NOTS has contributed directly to the development of scanning devices capable of producing and transmitting images of the earth or another body in space from a space vehicle. NOTS-developed devices have produced data on the earth's cloud cover—as well as data on the ultraviolet, infrared, and visible portion of the electromagnetic spectrum.

NOTS-developed portable receiving stations for satellite radio signals were used with the early *Explorer* program. These systems were modified later to receive data from the *Transit* satellites. Other organizations have been using them in a world-wide net. The units weigh about 3500 lbs., and can be set up by two men in two days. The systems measure frequencies transmitted from the satellite and correct for ionospheric effects before frequency measurements are computed.

NOTS also has developed a satellite-monitoring camera that synchronizes rate of travel with image motion to detect satellites too faint for recording by conventional ballistic cameras.

• **Home-bred motors**—For space propulsion as well as more conventional applications, NOTS has developed a family of variable-thrust liquid-propellant motors. One of these units has been used with considerable success in the NOTS soft-landing vehicle development work which has been partially funded by NASA.

The NOTS engine has one moving part, a variable area injector, which controls both fuel and oxidizer in the proper ratios. Hypergolic fuels are used and the engine is capable of an infinite number of restarts.

The Soft Landing Vehicle (SLV) has undergone tether tests, including lift-off, hover and landing. Most of the testing has been done with control through an umbilical system, but testing with an optical sensor control and self-guidance package in under way.

The present SLV propulsion unit develops 1300 lbs. thrust. Other tested versions of the NOTS variable-thrust engine range from 10-lb. to 3500-lb. thrust, and a clustered 20,000-lb.-thrust version is now in development.

Propulsion systems and propellant development are a forte at NOTS. Test facilities include the Skytop test area where the *Polaris* missile engines underwent a considerable amount of static test, and an environmental chamber for firing of engines under simulated space conditions. New facilities were added to the NOTS complement of propulsion development last year with the completion of a new laboratory for the Aerothermochemistry Group of the Research Department. Facilities include a solid-propellant combustion test bay, a liquid-solid-gas test area for the center's work in hybrid propulsion units, and a cold-flow test area.

Another major research unit of the Navy plant investment of more than $275 million at NOTS is the Michelson Laboratory—10.3 acres of one of the most self-contained research and development laboratories in the nation.

Other NOTS facilities include a Pasadena, Calif., annex which is engaged primarily in hydrodynamic studies; the Morris Dam facilities for development and test of underwater weapons; the Long Beach Sea Range; and the San Clemente Island facilities where a large percentage of *Polaris* launch testing was done. ■

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Monsanto High Heat Resins for space age applications

Monsanto Resinox high heat resistant resins were developed to withstand elevated temperature exposures. Now being used in missile and rocket components, laminates made with Resinox Resins have high strength-to-weight ratio, low rate of ablation, excellent shock resistance, low thermal conductivity, and stability at extreme temperatures.

Monsanto High Heat Resins include:

Resinox SC-1008—Phenolic Laminating Varnish. Designed for applications requiring extended exposure at temperatures to 500°F and very short term exposure in the 5000°F temperature range. Offers good ablation resistance.

Resinox SC-1013—Silane Modified Phenolic Varnish. For applications demanding extended exposure in the 500°F to 600°F range, and very short term exposure above 5000°F. Offers superior high frequency electrical properties.

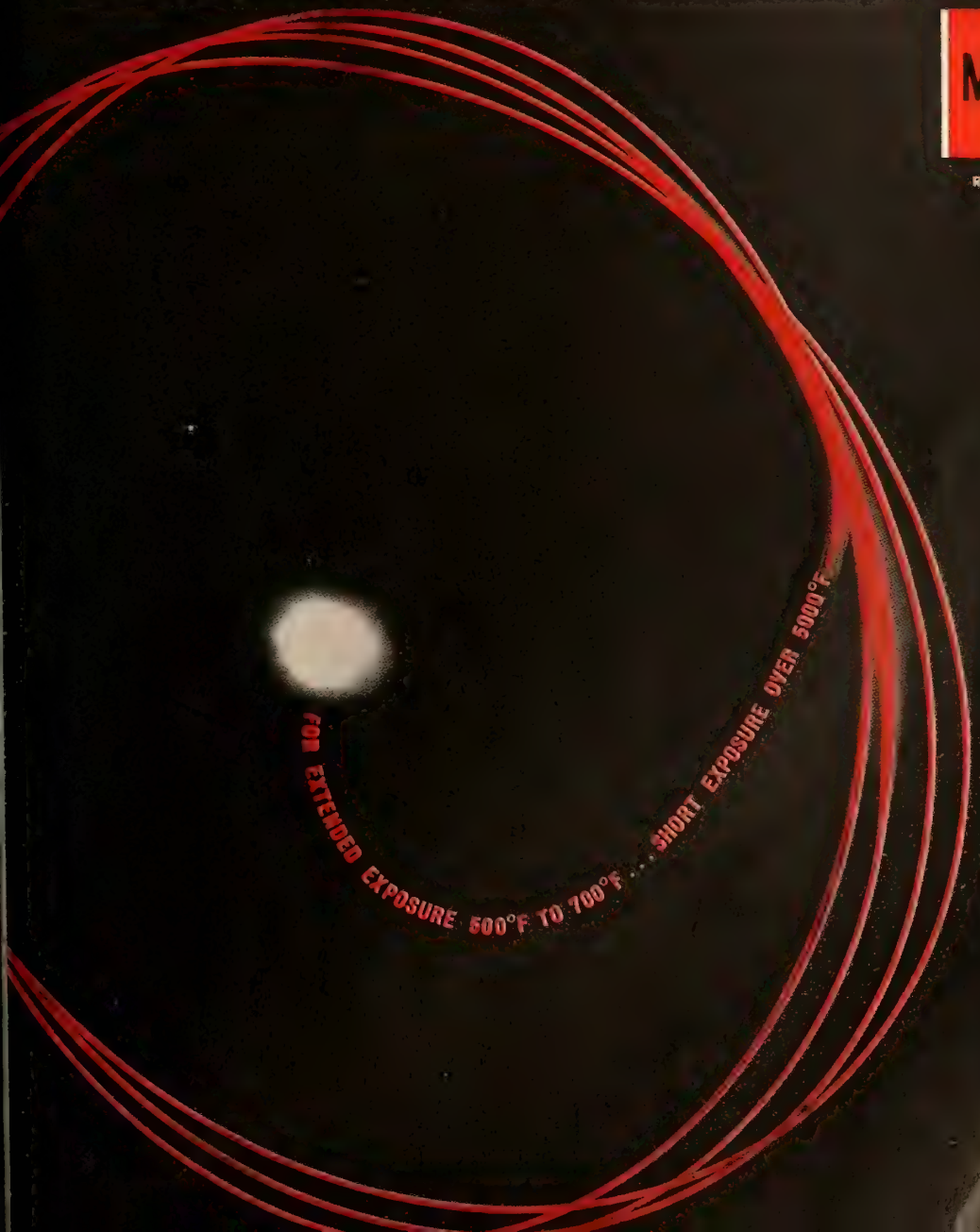
Resinox TS-5946—Elastomer Modified Phenolic Varnish. Recommended for blending with high temperature phenolic resins to increase tack for ease of layup, and increase flexibility and resilience of final laminate.

Resinox RI-4080—Modified Phenolic Resin Compound. Modified phenolic resin designed for use in moldings which must have short-term heat resistance to temperatures of 2000°F or higher.

Resinox RI-4009—Phenolic Resin Compound. Developed for use with glass and asbestos filter materials. It can be used in dry powdered form or as a varnish when dissolved in alcohol. For more information, write for a copy of "High Temperature Resistant Resins Folder" to Monsanto Chemical Company, Plastics Division, Room 828, Springfield 2, Massachusetts.

Monsanto

Resinox Reg. U. S. Pat. Off.



OCRD's Space Branch Oversees

Advent satellite program is by far the biggest, but the service has other interests including SECOR and mapping

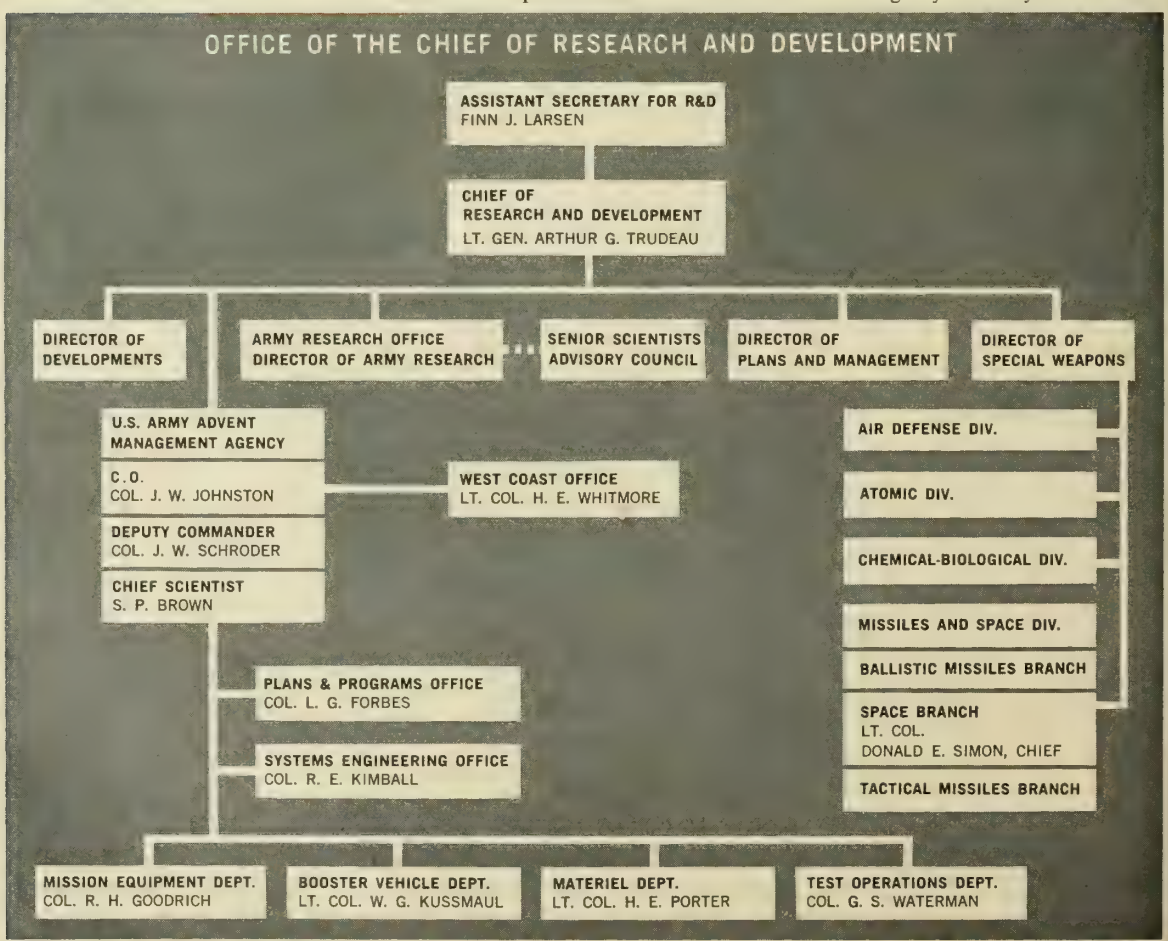
THE ARMY general staff has assigned responsibility for monitoring all Army space projects to the Space Branch of the Office of the Chief of Research and Development (OCRD).

This branch, headed by Lt. Col. Donald E. Simon, exercises considerable influence over the direction the Army space program takes—and over the financial support provided that program.

The office, operating within the entire Army R&D structure under Lt. Gen. Arthur G. Trudeau, is responsible for factual presentations and recommendations as to technical priority, feasibility, program interactions and budget.

• **Army space prospecting** — Although the large *Advent* program currently consumes most of the Army's space engineering effort and fiscal outlay, there are other areas where the service either is already involved in small-scale spending or is closely monitoring developments in future military use of outer space.

These include the *SECOR* program, studies of the need for satellite systems for emergency military communica-



Army's Space Undertakings

tions, investigation of lunar construction techniques and lunar mapping requirements, and close monitoring of meteorological satellite developments.

Under the direction of OCRD and DOD, the Army's *Advent* Management Agency (USAAMA) provides overall program management and technical direction for *Advent,* which actually is a tri-service Department of Defense R&D program.

Command of the *Advent* Management Agency changed hands on March 1, when Col. Joseph W. Johnston replaced Brig. Gen. William M. Thames. Gen. Thames, who had been in charge of the *Advent* groups since October, 1960, will retire after 30 years of Army service on June 30.

Col. Johnston, up for promotion to brigadier, was formerly Deputy Chief of Research and Development in the office of the Chief Signal Officer.

The development, fabrication, and testing of the satellite's communications payload and the extensive array of ground support equipment (including two huge tracking and communication facilities recently completed at Ft. Dix, N.J., and Camp Roberts, Calif.) is the responsibility of the Army's Signal Research and Development Laboratory at Ft. Monmouth, N.J.

The Air Force Space Systems Division (SSD), headquartered at Inglewood, Calif., is responsible for development and fabrication of the actual satellite—less the communications package—in addition to the booster, tracking, telemetry, and command subsystems. AF responsibility also extends into the launch, injection into orbit, and orbit control.

The third terrestrial communications center for use in *Advent* experiments will be aboard a Navy vessel. Equipment is now in the final phase of construction by the Bureau of Ships. The antenna installation aboard the ship will be somewhat smaller (30-ft. dish) than the ones at the ground sites. However, the installation is fully compatible with the entire net.

Major industrial prime contractors for *Advent* include: Bendix Corp.—shipboard, ground, and satellite communications equipment; Sylvania Electric Products, Inc.—ground communications antennas and construction of ground station facilities; General Electric Co. — satellite and flight hardware; and Philco Corp., subsidiary of Ford Motor Co.—tracking, telemetry, and command subsystems.

COL. J. W. JOHNSTON—*New Commander of Army's Advent Management Agency.*

• **Procurement route**—Army R&D procurement for *Advent* and other Signal Corps Laboratory projects is handled through the Ft. Monmouth Procurement Office, a branch of the Army Signal Supply Agency headquartered at Philadelphia. Col. L. M. Reiser heads the Ft. Monmouth office. Immediately below Reiser in the procurement chain-of-command is Lt. Col. J. J. Daly, Director of Procurement Operations.

Firms interested in doing business with the Army through the Ft. Monmouth office should first contact Mr. Charles Hoyt, Industrial Liaison and Small Business Representative. Companies applying for position on the bidders' list should have available company background material, financial reports, and associated information. The actual bidders' list is kept by the Business Analysis Office, under the direction of Mr. Kenneth Napier. A field-of-interest form is distributed from this office to prospective contractors.

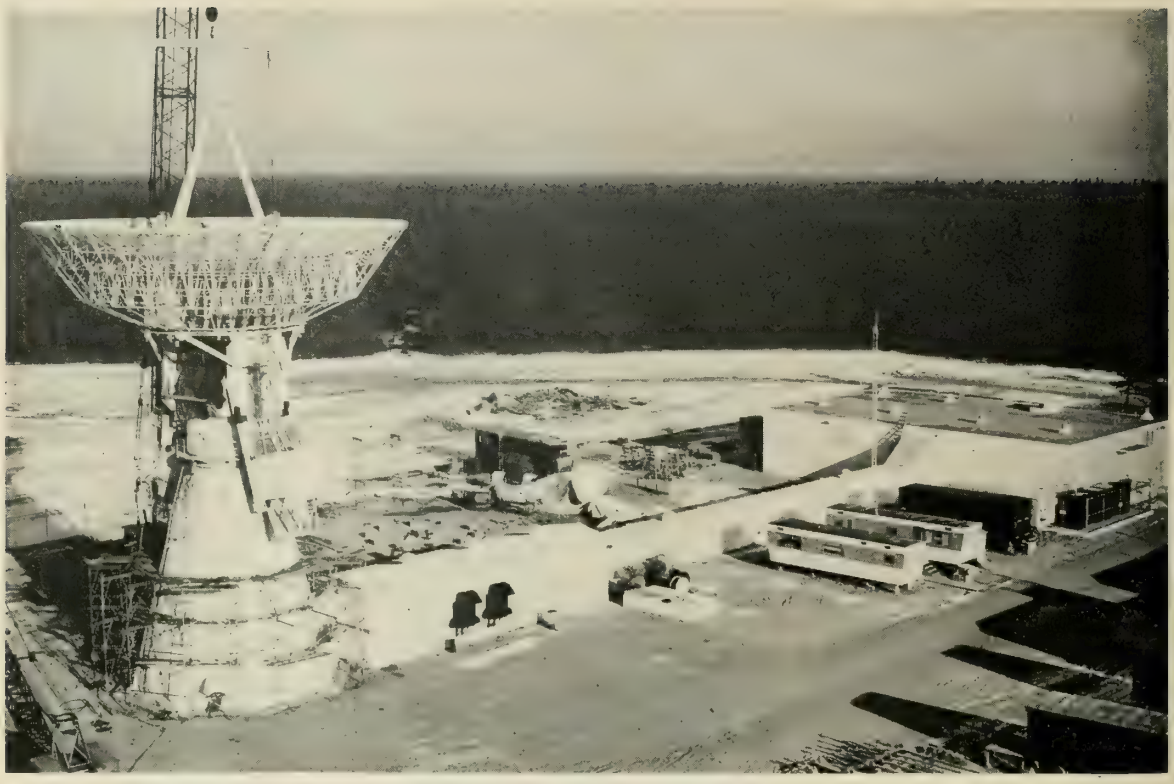
Col. Reiser says most research contracts coming out of Ft. Monmouth are of the cost-plus-fixed-fee variety. For contracts involving actual hardware, such as development of service test or pre-production models, there is a trend towards award of incentive-type contracts. In most cases, a negotiated procurement is transacted—as opposed to the formal advertising method, with requirements appearing in the Department of Commerce "Synopsis of U.S. Government Proposed Procurement, Sales, and Contract Awards."

First indications of *Advent's* effectiveness should become known immediately after the first round of flight tests get under way. According to Gen. Thames, this first airborne phase in low-altitude orbit will test the power supply, attitude and orbital control functions, communications, tracking, telemetry, and command subsystems.

• **Design may change** — Though initial design is already firm, some *Advent* engineers are keeping an eye on certain areas—the power supply in particular—where changes may be in the offing.

Current design calls for nickel-cadmium batteries to serve as back-up for the main power supply array of 35,000 solar cells. However, the Army is also investigating the use of silver-cadmium batteries in this support role. They are also studying a switch from p-on-n to n-on-p type silicon semiconductors in the solar cell area to improve resistance to radiation damage. Maximum solar cell output is approximately 650 watts, with the estimated maximum power drain listed as 480 watts.

The Army is also watching the development of other types of power supplies, such as fuel cells and nuclear devices, though it has begun no specific programs of its own. The current power supply—including the cells, paddles, and drive motors—employed in *Advent*



PROJECT ADVENT space communications antenna, believed to be the world's most accurate, nears completion at Army's Ft. Dix, N.J., Sixty-ft. parabolic reflector weighs 9 tons.

satellites represents the largest single weight figure.

Tests of the attitude and orbital control function at low altitude will be made to the same precision stabilization accuracies demanded at the synchronous altitude. An inertial wheel—cold gas jet system will be used for attitude adjustments, with both cold and hot gas systems employed—for coarse and fine orbital corrections, respectively. The three-axis attitude control system is under satellite control, while the ground stations alter orbital position.

To a great extent, success of *Advent* depends upon reliable attitude control for aiming the directional antennas, and also on precise orbital control to maintain position over a fixed terrestrial point. The third governing factor in overall accomplishment will be the ability of microwave electronics gear to operate dependably and continuously while unattended in the space environment. The Army has specified a minimum wear-out life of three years within the design requirements.

• **Jam precautions** — The military success of *Advent* is also dependent on creation of a system which resists enemy jamming and is secure from message interception. To insure this, engineers have incorporated special wide-band modulation capabilities in the design.

The total system bandwidth capability for *Advent* satellites will be on the order of 40 mc, with an input frequency in the SHF range and an output in the VHF range. Power output for each of four RF channels is a nominal one watt. Each channel is capable of handling in excess of 500,000 data bits per second, as well as 12 voice circuits. During the first series of launchings the channels will operate in pairs, but in the later synchronous altitude flights all will operate simultaneously. Planar triodes will be used as RF power amplifier devices in early launchings, but will likely give way to traveling wave tubes in later designs.

Three antennas will be deployed aboard *Advent* satellites: a receiving horn; a 20-in. parabolic relay dish (both producing a beamwidth sufficient to cover the visible earth); and an omnidirectional antenna for tracking, telemetry, and command functions.

During the experimental flight tests, about 300 test points on and inside the *Advent* satellite will be telemetered to ground stations.

• **Ground sites**—The ground-based tracking and communication equipment at Ft. Dix and Camp Roberts are believed to be "the most accurate of their kind in the world today," according to Army officials. Equipment at both sites is identical.

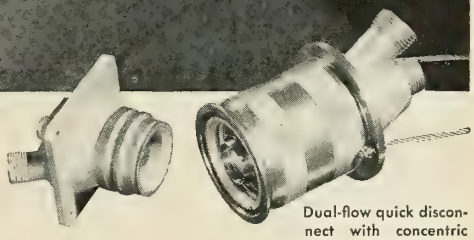
The 60-ft. parabolic reflectors, each weighing 9 tons, are mounted on top of 65-ft towers at both sites. Each tower, built on a 30-ft. concrete foundation, was constructed of 190 tons of 1-in. steel plate and is held together with 3 tons of welding rod. Despite the heavy weight, the antenna turret can make a complete rotation in 60 seconds.

General Thames says the antennas are accurate to within 0.024 deg. He points out that an antenna aiming error of only 1 deg. would miss a satellite at synchronous altitude by 385 miles.

The antennas are connected by 200-ft. passageways to 6000-sq.-ft. operations buildings, where most of the control equipment is housed. The floors in these areas are made of an RF shielding aluminum alloy, and the concrete frames have a metal insulation.

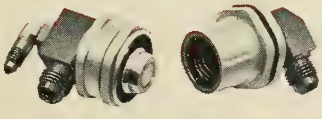
General Thames, in summing up *Advent's* role in this country's military space plans, sees unlimited potential for strategic communications in a global net of *Advent* satellites. He feels that our ability to exploit space for this purpose would provide coverage for previously inaccessible areas while freeing defense communications from the many earth-bound transmission difficulties and limitations. ⁂

YES, HERE ARE EXAMPLES

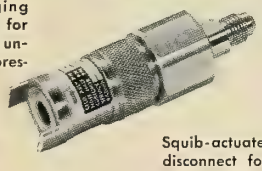


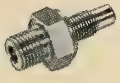
Dual-flow quick disconnect with concentric fluid passages for pressure and return lines.

Electronic coolant system quick disconnect for rack and panel mounted modules.

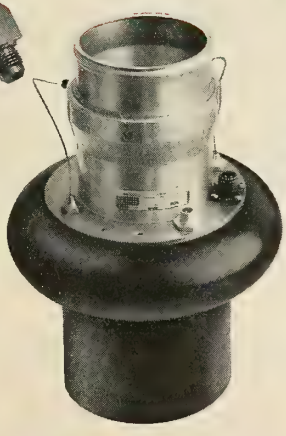


Pneumatic charging quick disconnect for safe disconnection under full system pressure.





Squib-actuated quick disconnect for missile air cooling system.



Silicone coolant line quick disconnect for airborne electronic equipment.

These special quick disconnects are examples of Aeroquip imagination and know-how in coupling design and manufacture. Each was designed to meet specific customer requirements. No two are alike. Aeroquip's total experience covers a wide range of fluids, temperatures, pressures, operating and performance characteristics. Whatever your fluid line disconnect problem, it can be solved quickly and effectively at Aeroquip. Mail the coupon below for full information.

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SSD Runs Space Show

(Continued from page 99)

gineering and technical direction of new Air Force missile/space programs. Some 75% of its work today is in the space field.

Aerospace Corp. is involved in Air Force space systems from initial planning through successful demonstration of an operational system. Its responsibilities fall into three areas:

• **Systems research and planning**—Here, it assists SSD in the conception of military space systems to fulfill military requirements and in preparing initial general specifications. Evaluation of technical proposals submitted by industry is part of this job.

• **General systems engineering and technical direction (GSETD)**—This involves technical management of programs selected by the Air Force for conversion into hardware by industry. General systems engineering deals with the problems of putting together a complex system from a number of perhaps equally complex subsystems, analysis of subsystems for improvement and supervision of systems testing. To accomplish this, Aerospace provides technical direction for associate contractors on Air Force space programs.

Aerospace Corp. currently is involved in two areas of systems engineering which are exceptions to its usual duties. Normally, the detail work of engineering a subsystem is left to industry. But in the case of the *Atlas* booster for Project *Mercury*, Aerospace was assigned the task of detailed systems engineering due to the unusual safety requirements involved in man-rating an ICBM. And in the *Midas* program, where general systems engineering and technical direction already had been contracted with Lockheed, Aerospace is providing "technical surveillance," monitoring the program for the Air Force to assure that benefits from other programs which might not be known to Lockheed are incorporated in the *Midas* system.

"While we're not in a line position to say 'do it that way,' we can give the information to the Air Force and make sure that they at least are in a position to take advantage of it if they want to," is the way an Aerospace official explains the "technical surveillance" assignment.

Among other programs, Aerospace is performing general systems engineering for *Satellite Inspector*, the *Dyna-Soar* booster, the launching and final stage vehicle for *Advent*, the *Thor Able-star* booster for *Transit*, and orbital interceptors. The latter is a research program on system concepts for destroying a ballistic missile during launch—a natural follow-on to the *Midas* program.

• **Laboratory research operations**—These, intended to provide Aerospace with the broad research base which will give it an objective competence, are conducted in two areas.

The first covers research and experimentation to assist the firm in its systems research and engineering. The second involves applied research to aid Air Force in its management of applied research programs carried on by industry under Air Force contracts.

Among laboratory research projects now under way at Aerospace are studies in chemical, nuclear and electrical propulsion. Studies are being conducted on winged and ballistic re-entry configurations. Heat transfer studies are receiving considerable attention. In the field of materials, Aerospace researchers are investigating solid-state physics, materials, structures and environmental effects on materials.

Electronics research includes advanced solid-state circuits for space communications and detection systems, research in electromagnetic and communications techniques, and in attitude and position sensors and controls. In space physics, studies of the atmosphere, solar and stellar radiation and the radiation belts are under way.

Aerospace now employs some 3200 persons, 1000 of whom are scientists and engineers—a group expected to increase to 1500 in the near future. This compares with a personnel total of 3630 at SSD.

The Aerospace Corp. budget for the fiscal year ending June 30, 1962, is about $55 million, according to Vice President-Administration William Drake.

Contracts issued by Aerospace fall into two categories:

Those for services, such as janitorial, totaling between $3 and $5 million a year.

Those for technical assistance to augment or supplement the Aerospace capability, totaling about $2 to $2.5 million in the past year.

"We think in this latter case that such subcontracts should be limited to the procurement of scientific effort available in industry or in other nonprofit organizations such as universities where it would not be appropriate for Aerospace to try to develop this capability in-house," says Drake. These usually are short-term, three-to-six-month contracts for solution of a particular problem.

This relatively small amount of subcontracting is likely to remain so. Hardware related to systems is procured by the Air Force itself. (See p. 44 for SSD procurement.)

Reliable space radiators for satellite cooling

Garrett-AiResearch has designed, fabricated and tested lightweight space radiators, utilizing proven hardware concepts throughout. Active radiator systems can cool electronic equipment, fuel cells, stable platforms and environmental systems operating from 400°F to cryogenic temperatures.

AiResearch is foremost in space radiator design and manufacturing, and is highly experienced in weight optimization techniques, meteoroid protection, transient temperature analysis, fabrication techniques and emissive coating characteristics.

Present AiResearch space radiator development and production programs include systems for both manned and unmanned space vehicles. Other types of space heat transfer experience include the Project Mercury and Dyna-Soar systems.

AiResearch has more than 20 years of experience in the design, development and manufacture of heat transfer equipment for aircraft, missiles and space vehicles. Your inquiries are invited.

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Materials Drive

(Continued from page 70)

Compositions similar to binder materials but with greater emphasis on the ability to form tenacious interfacial bonds are required as structural adhesives. Other methods of joining—such as brazing, welding and mechanical fastening—are available and give good performance under particular conditions. But adhesives have a greater versatility in intricate substructures and potentially greater simplicity for assembly and repair purposes. Certain of the inorganic structures with some modification offer a possible means of obtaining adhesives for use above 1000°F in the next five or more years. Present indications are the temperature limit of intrinsic polymeric stability is somewhat lowered when modified and compounded for adhesives.

• **Carbonless chemistry**—Inorganic polymers based on boron and nitrogen are expected to extend operating temperatures beyond 800°F in the next three to five years. This has already been done in some fluids and the advance is expected to be in formulations for matrix resins and adhesives.

This work is complemented by recent accomplishments in synthesizing boron-phosphorous compositions which will lead to formulations with equal or better heat resistance. There is a potential here for fluid applications.

New classes of materials are possible with polymeric combinations of arsenic and antimony, metal-containing coordination complexes and organics.

Ferrocene derivatives show immediate possibilities as radiation-resistant additives. The very intractable nature causing difficulty in characterizing early ferrocene derivative polymeric forms is a good indication that extremely stable, radiation-resistant materials may evolve in the near future.

The Air Force expects new inorganic polymers will be available in about five years for use in the 800° to 1200°F ranges.

Fluids work covers heat transfer, power transmission, damping, and gyro flotation. The primary raw materials involved include mineral oils, diesters, silicones, disiloxanes, silicate esters, phosphate esters and polyphenyl ethers.

Research emphasis is on fluids with capabilities in the 1000°F range. Exploratory research is under way, concentrating on semi-organic and inorganic molecular structures. Liquid metal work is devoted to gathering data on heat transfer coefficients and optimum operating conditions—with an eye toward containment materials and instrumentation compatibility up to 2500°F.

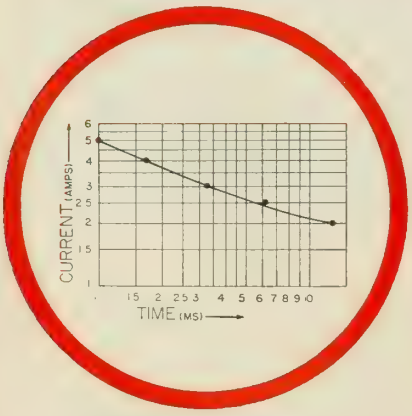
The Directorate of Materials and Processes is funding a great deal of graphite research aimed at solving the production problems in obtaining better uniformity of properties throughout a piece. Definite progress is being made.

Part of the work also involves utilizing the known forms of graphite to tailor-make bodies for specific service requirements. The control of thermal expansion should make it possible to match the expansion of graphite with that of any suitable protective coating, since oxidation remains one of its undesirable traits.

Until this happens, applications of the various shapes and composites will continue to be limited by lack of suitable coatings. Greater densities are also being sought.

In the next five years, some of the potential of mixed graphite structures should be clarified. These are graphites containing dispersed particles such as refractory metals, stable carbides, and nitrides. Air Force experts stress the lack of fundamental knowledge in many graphite areas—from a basic science standpoint. But the nature of the material is such that it will be an important part of advanced systems. ⁂

NEED 1 AMP - 1 WATT NO-FIRE?



Typical functioning time characteristics of a McCormick-Selph 1 amp-1 watt no-fire ignition system

McCormick-Selph Delivers Without Sacrificing Performance

McCormick-Selph not only recognized the importance of electromagnetic radiation safety (as required by new AFMTC Ordnance Standards)—but took the extra steps to design a 1 amp-1 watt no-fire system without significantly sacrificing conventional electroexplosive device (EED) performance characteristics.

The key is a new ignition system that enables McCormick-Selph to produce a family of EED products (Initiators, Pressure Cartridges, Igniters, Detonators, etc.) capable of fast response and performance reproducibility. This unique ignition system may be substituted directly into most existing McCormick-Selph cartridges (single or double bridgewire circuits) or designed into units comparable in size to standard components to simulate the output of essentially any EED.

To help you solve your EED requirements, please write or call McCormick-Selph's Applications Engineering Department:
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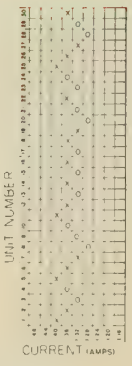

Above: results of a typical Bruceton Analysis Report recently performed on a McCormick-Selph initiator incorporating the new 1 amp-1 watt no-fire ignition system. 99.9% Reliability — 95% Confidence/Mean: 1.34 amperes/Upper Limit: 1.514 amperes/Lower Limit: 1.166 amperes/Standard Deviation: .0296 amperes.

McCORMICK SELPH
EXPLOSIVE ORDNANCE

to ignite to detonate to actuate to eject to open to close to pull to push to stabilize

Circle No. 31 on Subscriber Service Card

AF Test Centers

(continued from page 115)

Pt.. Arguello, NASA's *BIOS* launches have been made from there, and the AF's *Atlas-Agena* launchings for *Samos* and *Midas* also came from NMF-Pt. Arguello.

The AF has two *Atlas-Agena* pads at Pt. Arguello, and two more are under construction.

Although not, by command function, a part of VAFB, Pt. Arguello has become a part-time adjunct of VAFB through usage. The NMF, however, is strictly a PMR function under overall Navy control. At the Pt. Arguello facility is much of the key radar installation for tracking launches both from Pt. Arguello and VAFB.

• **Holloman AFB** — Home of the Air Force Missile Development Center is Holloman AFB, located near Alamogordo, N.M.

Principal mission at the Center is development testing of guided missile weapon systems. It also supports outer-atmosphere research with rocket probes and balloon experiments, and performs research related to biomedical problems and hazards associated with manned space flight.

A $14-million test center, AFMDC consists of two principal operating directorates: Range Operations, which works with the Army's White Sands Missile Range to support tri-service missile tests; and the Central Inertial Guidance Test Facility, which is the Air Force's independent test group for all inertial-type missile and space guidance components and systems. The Aeromedical Field Laboratory performs advanced research in space medicine.

• **CIGTF interests** — Most publicized of all AFMDC facilities is its famed 35,000-ft. high-speed sled track, operated by the Track Test Div. of the Guidance Test Facility. Believed longest of its kind in the world, it has been used for both hardware and human acceleration tests. It also serves as a major U.S. controlled-test facility for impact tests.

The Guidance and Control Division is now equipped to follow guidance system testing all along the line from component development through final system test.

The Computation Division performs the necessary data reduction and analysis to support guidance system development tests. It now employs a PACE analog computer and three Univac digital computers. A real-time system for missile control will soon be available.

New facilities soon to be added include a new highly precise centrifuge, a stellar-inertial test facility (due by the end of '63), and a guidance evaluation missile (operational late in '63). The latter will be a three-stage missile having reverse thrust in the last stage. It will have a soft-landing capability for test-item recovery.

• **Eglin AFB** — The Air Proving Ground Center, a 45,000-sq.-mi. water-land complex surrounding Eglin AFB in northwestern Florida, is charged with the responsibility of testing aircraft, missiles and items of aerospace equipment.

The Eglin Gulf Test Range is part of the facility. This is believed to be the most accurately instrumented range in the country. Extending from Eglin, West, substations along Florida's West on the Gulf of Mexico, down to Key Coast monitor and collect data all through any given test flight.

The facility has a SAGE tie-in for intercept-missile testing. Currently, the main effort centers around electromagnetic warfare. This is due to the SAGE proximity and the relatively low industrial interference in the area around the range. ECM equipment testing could easily disturb military and civil radar and radio services; this is one of the reasons why a significant amount of ECM testing has been shifted over the past years to Eglin from the Boston area. ⌘

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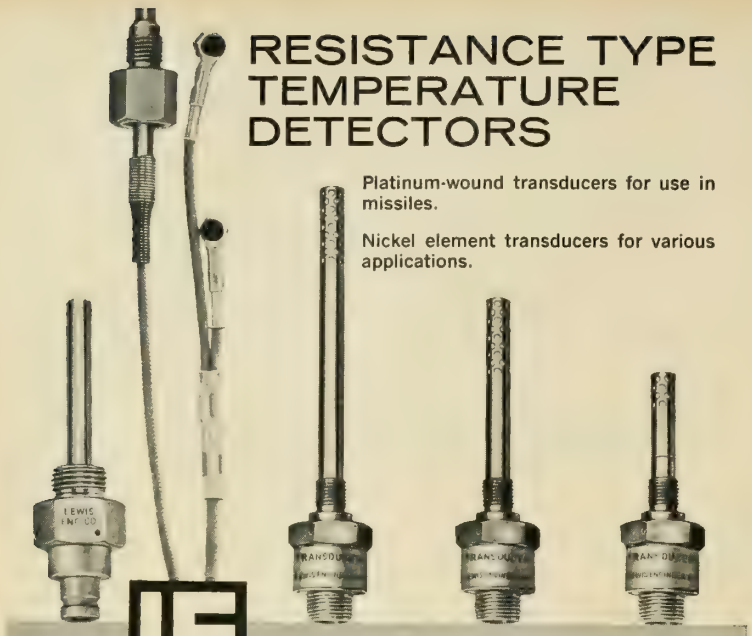

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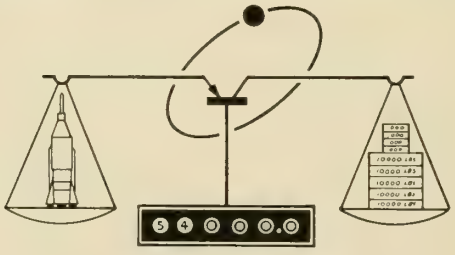

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BuWeps, ONR, NRL

(Continued from page 125)

a year, while *Injun II*, part of a group of five satellites, failed recently when the rocket second-stage failed to develop enough thrust. *Injun IIB* is now in preparation.

Van Allen's future projects involve searching for magnetically trapped particles or radiation belts around the moon and planets. Instrumentation has been designed for use on the *Ranger* moon rocket and on the proposed *Mariner* shot (Venus fly-by). Some of these experiments must be planned about three years in advance. The Van Allen group is supported by ONR and NASA. Total ONR funding for this work during the current fiscal year was $239,000.

• **Contracting with ONR**—Any qualified scientist or organization is eligible for a contract with ONR; the overtures can be made either informally —through a conversion with, or letter to, the appropriate department — or formally through a proposal and five copies.

The formal proposal should be directed to the ONR Branch Office serving the area in which the contractor is located. There are offices in Boston, New York, Chicago, San Francisco, Pasadena, and London, England. Further information on contracting is in the booklet called, "The Office of Naval Research Contract Research Program," ONR-1, Department of the Navy, Washington 25, D.C.

• **NRL in astronautics**—All of NRL's R&D work in astronautics is done in-house, except for the building of components which can be purchased cheaper in the open market.

NRL works as a service organization for the Navy's Bureaus and for the other military services and governmental agencies. To a limited degree, it acts as a consultant to contractors holding Navy contracts.

Upper-air physics comprises a continuing program at NRL and involves some rocket sonde work. Dr. H. Friedman is in charge of this program. In addition, he is in charge of a rocket spectroscopy project which calls for sending up about 10 *Aerobees* a year—purchased from Aerojet-General.

Other research projects include *Lofti*—a Bureau-of-Ships-funded satellite program—under the direction of E. Toth, and BuWeps' *Spasur*, under the direction of NRL scientist Roger Easton. In addition, NRL has a continuing interest in basic research in astronautics and to a limited extent is pursuing it in line with the Navy's mission. ⁂

OAR Upgraded

(Continued from page 123)

EM wave behavior and of the influences of the media through which the signal propagates. "Novel approaches to the classic antenna research goals of side lobe reduction and higher gain" are also being sought.

—*Meteorology.* Aspects of meteorology of particular interest to AFCRL are cloud physics, circulation and diffusion processes, satellite meteorology, climatology, forecasting techniques, weather radar research, and the development of new meteorological instrumentation. Moreover, CRL is developing methods for interpreting the vast amount of data obtained from weather satellites.

—*Energy conversion.* In progress at AFCRL are about 50 individual investigations into various aspects of energy conversion. The research is concerned with how energy is absorbed, stored, transformed and dissipated at the molecular level. The work includes studies of thermionic generators, thermoelectric converters and photosynthesis among other means of transforming free energy into useful energy.

• **Mission of ARL and EOAR**—In-house research in the physical and aerodynamic sciences is ARL's primary responsibility. However, during Fiscal Year 1962 the Laboratory had a $6.6-million budget for contracted basic research which would "extend or directly complement in-house activities."

EOAR provides a contact between USAF and scientists in the free countries of Europe and the Near East. These scientists can work through EOAR to submit any research proposal that might be of interest to any Air Force agency; and if the proposal is accepted, EOAR will negotiate and monitor the contract. Thus, EOAR operates within the entire Air Force from whom it derived a $5.75-million budget for contract research during the current fiscal year. Part of this money came from OAR.

• **How to submit a research proposal**—The easiest, cheapest and, happily, the best way to find out if OAR is interested in a piece of research is to send an informative but not elaborate letter to what the contractor considers to be the appropriate facility and individual. A briefing will serve as well as a letter.

From this initial contact, the prospective contractor will be in a good position to know what specific proposal to present and where to send it. A subsequent interview with the selected activity may tell the contractor whether his proposal is considered to have any merit. In the negative instance, this will save him the time and expense of preparing a more formal proposal.

OAR has a refreshing philosophy because "(it) is not interested in telling research scientists exactly what they should do." OAR states that "the most productive ideas originate in the laboratories and the minds of the men who actually do the research" and these are the men who should submit the proposals. "Nor does OAR automatically reject the unconventional—in fact, it encourages originality, both in subject and approach."

• **Literature** — For more information on the interests of OAR and how to do business with the organization, the following literature is helpful: Office of Aerospace Research brochure, Office of Aerospace Research, Attn: RROS-1, Tempo D., Washington 25, D.C.; AFOSR brochure and AFOSR Grants for Basic Research, AF Office of Scientific Research, Attn: SRGL, Tempo D, Washington 25, D.C.; AFCRL brochure, AF Cambridge Research Laboratories, L. G. Hanscom Field, Bedford, Mass.; and the ARL brochure (ready in about 60 days), Aeronautical Research Laboratory, Wright Patterson AFB, Dayton, Ohio. ⁂

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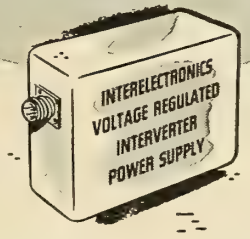

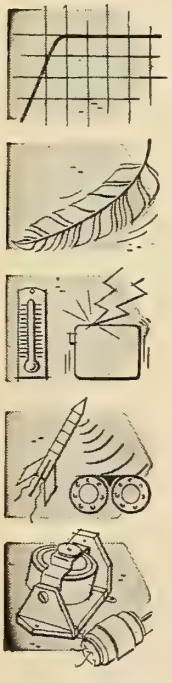

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PMR Load Swells

(Continued from page 130)

Dember made these points:

—The key to the future of the *Hydra* program, "a very severe problem, is development of a guidance system which is either self-erecting at sea, or a system which will allow you to transfer your guidance from the ship to the missile throughout the stages of undocking and erecting. In launching from the water, not only do you lose physical contact with the rocket, unlike the situation with a land-based pad, but you put the rocket into an environment where it is exposed to the wave motions of the sea. This can be solved, but industry does not yet know how to produce an adequate system cheaply enough."

—"We need cheaper radar beacons. If you fly a little probe, it costs, maybe, $5000 to buy a radar beacon to track it. This is completely out of proportion to the cost of the probe.

• **Lots of room**—Looking to the future in PMR growth, Radom says, "as we go island-hopping in the Pacific, our expenses will go up."

As more military programs, such as *Nike-Zeus*, move out into the far regions of PMR, there will be requirements for "more of the same."

Major elements of PMR are the Range Support Directorate, the Technical Support Directorate, the Naval Air Station, Point Mugu; the Naval Missile Facility, Point Arguello; the downrange facilities of the Hawaiian area, Kwajalein, and Eniwetok, and the so-called tenant complex of attached and resident military and civilian units. NMC is the largest tenant organization at Point Mugu.

Under "Ranges and Real Estate," PMR lists five ranges over its vast geographical expanse: Sea Test Range, supporting development of air-to-air, air-to-surface, surface-to-air, and short-range surface-to-surface missiles, and fleet training with these missiles; IRBM range, a sector extending 1500 miles westward to sea from Point Arguello; ICBM range, a corridor extending west from Point Arguello; Polar-Orbit range, providing a capability for launching satellites southward from Point Arguello; Anti-missile range, for missiles fired from the coast or such installations as the *Nike-Zeus* facility at Kwajalein.

For industry seeking to do business with PMR, first point of contact is the Supply Management Office headed by Capt. A. C. Jackson. Richard M. Gee, procurement analyst in that office, suggests a potential vendor or contractor get on the mailing list of the Navy Purchasing Office in Los Angeles, which sends out notice of requirements. ⌘

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ESD's Stress on Space

(continued from page 107)

scribed as a master approach for anticipating change based on advancements in the state of the art in both electronics and weapons here and abroad.

A large part of Advanced Planning Office effort now is concerned with space requirements. Needs over the next three years are clear. The following five years, however, present a problem in trying to determine Space Age requirements and accomplishments, according to Col. B. B. Townsend, deputy for AP.

Principal assignment of AP, however, is to study techniques and the characteristics of various systems rather than hardware.

The group consists of about 50 highly experienced specialists who perform most of the conceptual work. Design tasks are usually handled on the outside—mostly by the Mitre Corp. A few of its planning studies are performed by contractors, but bidders are usually held to about three. Typical contracts are in the range of $200-400 thousand. (Over the past eight months, only three industry contracts have been awarded.)

• **Technology**—Deputy for Technology is Col. R. M. Wray, who directs a $115-million research and development effort covering seven areas of technology. His group of nearly 130 people has the task of securing the latest and most useful information available for application to command and control system development.

Wray's group consists of a Directorate of Applied Research, an Operational Applications Laboratory, a Systems Design Laboratory, and a Directorate of Instrumentation and Advanced Development. The latter group takes over projects following the applied research, to bring new equipment into being and develop new processes not identified as systems.

Thus, the output from Technology is for direct application or development assistance in next-generation systems.

In operation, Planning Objectives are directed to the Applied Research Directorate. The PO's indicate the overall requirements for a potential system or a capability that may be of future benefit to the Air Force. A coordinator is assigned to each PO for management control, and research requirements are assigned to the appropriate Technical Area Managers (TAM's). Tech Areas include electromagnetic wave techniques, computer and data processing techniques, computer and data processing techniques, surveillance techniques, communications techniques, electromagnetic vulnerability reduction, electronics techniques and intelligence techniques.

The various TAM's develop programs and control funds released to the various work agencies: Lincoln Lab, Avionics Directorate of ASD, Cambridge Research Lab, Rome ASD, or the Mitre Corp. (A breakout of funding for approved programs is approximately as follows: RADC—$40 million; CRL—$18 million; Lincoln Lab—$19 million; ASD—$17 million; and Mitre —$2 million—about 7% of Mitre's overall USAF budget.)

Areas of greatest emphasis today are surveillance, electronics, technique communications, and intelligence, in that order. Computer and data processing is small now, but the effort is expected to receive increased emphasis starting in FY '63.

It also is worthy of note that each TAM manages all the work in a given Technical Area within all of the Systems Command.

The one new area of responsibility at ESD is Range Instrumentation, under the Deputy for Technology. A separate Division for Range instrumentation has been in operation since last October. Its mission is to meet the need for continued development of range instrumentation that is in consonance with

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$400 million for L systems . . .

future missile and space systems testing at Air Force Ranges, and, at the same time, to assure maximum return for Air Force funds expended by integration of the development effort.

ESD makes use of the technical and scientific support of The Mitre Corp., Lincoln Laboratory, and the various Air Force R&D agencies to perform this task.

Operational Applications Lab is primarily concerned with the man/machine loop. Much of its work has been associated with the 'L' command and control systems. It has performed many personnel subsystem studies and is working now with teaching-machine research, as the concept applies to highly complex computerized systems and adaptive data processing systems.

Eventually most data processing and simulations required by ESD will be performed by the Systems Design Laboratory with the technical assistance of Mitre. Most of this work now is being performed by Mitre.

Working with Applied Research, System Design hopes someday to have extensive display facilities. The development effort now is very small, but it, too, will be expanded.

Wray says this is an area that urgently needs advancements. We need displays, he said, capable of best showing selective processed command and control input data. But we must first find out how selective to be.

• **Systems Management**—All of the Air Force command and control systems are under the direction of ESD's Deputy for Systems Management, Col. N. J. McGowan.

Current expenditures for all systems are running about $500-700 million per year.

The group is responsible for C&C system administration, planning, design, and implementation. After turnover to the operational command, it continues to be responsible for systems improvement and updating. Finally, it has the overall task of trying to provide some integration of all systems.

Today there are 15 L systems (431L and the new 482L have been combined under a single office to better implement the two FAA systems). Of the 14, seven are associated with the space effort. FY '62 authorizations total almost $400 million for these seven systems, which include:

425L—NORAD Combat Operations Center

438L — Intelligence Data-Handling System

465L—SACCS, Strategic Air Command Control System

466L—Electromagnetic Intelligence System

473L—AF Control System

480L—Spacecom, Air Communications System

496L—Space Track

Each L system is assigned at conception to an SPO (System Project Office) and is grouped under a single System Program Director. The director is responsible for the overall system acquisition until it is approved and turned over to the using agency or command.

Besides the various SPO's, Systems Management has its own test staff, plus an engineering support and systems integration offices.

The depth of this organization and its very great in-house capability are due in no small measure to the policy of hand-picking SPO directors and its endeavors to keep them on the projects

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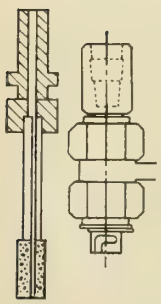

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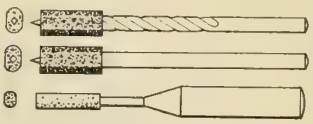

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through completion.

• **A pair of arms**—If one considers the three main operating units—Advanced Planning, Technology and Systems Management—as one arm of ESD, then certainly the second strong arm must be the Mitre Corp.

The degree of integration by ESD and the not-for-profit Mitre organization is almost total.

A flyoff from M.I.T.'s Lincoln Lab, Mitre has grown with ESD's assignments to its present strength of about 1700 employees, two-thirds of which are technical personnel. Nearly 600 of these are highly experienced creative scientists and engineers.

Mitre is a principal work agency for ESD, and as such supports all of the division's efforts. Some assistance in data processing systems is provided by another not-for-profit organization, the Systems Development Corp., under subcontract to Mitre.

FY '62 contracts held by Mitre are expected to total about $30 million. All but $3 million of this is from the Air Force.

Mitre is not a hardware manufacturer. As an ESD technical associate, it is a "think" organization geared to problems of command and control. Although it is concerned with some of the tools of war, it also is concerned with the techniques of waging war and in defining the future tasks in space.

Thus, in its long-range planning analyses, Mitre attempts to set thresholds as a function of the war temperature.

Technical assignments doled out to Mitre vary considerably—from simple consulting services to system management. On 425L, for example, Mitre is the cooperating system manager with ESD's SPO. Sometimes it develops the system conceptual design and then serves as the intermediary between user and builder. (Also, see M/R, Dec. 4, 1961, p. 12, for a more detailed description of Mitre organization and operation.)

Mitre's technical staff increased steadily in 1961 and is continuing to increase in 1962 to the extent necessary to fulfill the corporation's obligations to ESD.

• **Other local support**—Two other units of the Hanscom Complex serve ESD: Lincoln Laboratory and Cambridge Research Laboratory.

Lincoln is a tri-service-sponsored applied research and development organization. Although its workload is specified by the three military services, it is heavily oriented toward the sciences contributing to ESD's command and control mission.

Cambridge Research Lab is a part of the recently formed Office of Aerospace Research. Because of its proxim-

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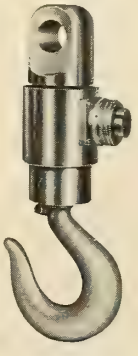

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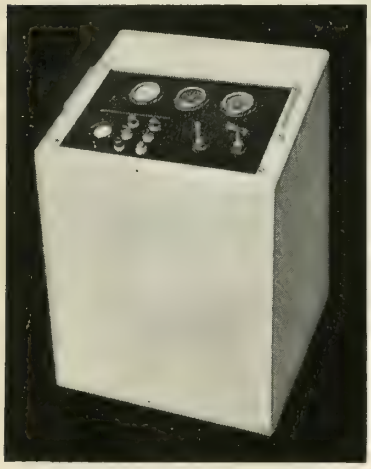

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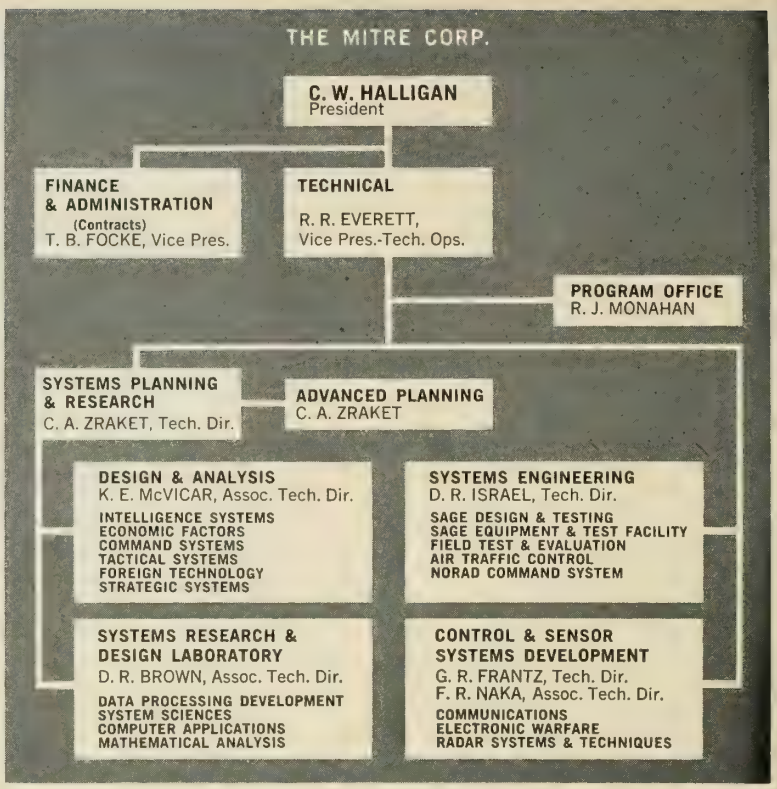

ity to ESD, approximately 20% of CRL's total applied reseach effort in electronics and geophysics is performed for the division.

• **ESD procurement**—The Deputy Chief of Staff/Procurement and Production is currently responsible for over $1.9 billion in contracts.

Only statistics can indicate the vast complexity of contracts annually handled by the group. In 1961, for example, 1784 R&D contracts alone were being administered for a total funding of $486.6 million. During the same fiscal year, 1188 R&D Purchase Requests were processed for a total of 372 new contracts and a new obligation of $108.6 million. This is big business.

In charge of this operation is Col. Reagon A. Scurlock, assisted by William J. Irwin. The group has been reorganized twice since July 1, 1961.

Because of the R&D effort at ESD, procurement policies remain fluid. As a general rule, however, systems contracting is performed in the System Project Offices. DCS/P&P provides support. In the future, it is expected that Contracting Officers will be assigned directly to the various SPO's.

In the Directorate of Procurement, separate divisions are employed for R&D and Purchase.

R&D procurement, as already indicated, is large. Projected FY '62 workload is expected to amount to 1400 R&D Purchase Requests and result in a total funding of $130 million in new contracts.

The division negotiates and administers Lincoln Laboratory and M.I.T. contracts and supports the Office of Aerospace Research in its procurement actions.

Average R&D contracts are from $35-40,000. Excluding Mitre Corp. and Lincoln Lab contracts, most are for advancing the state of the art in the various technologies.

About 60% of all R&D contracts are with industry, the rest with not-for-profit organizations.

Purchase Div. contracts total roughly several million dollars per year. Sixty percent are devoted to the support of ESD technical activities.

Base procurement was $10 million for FY '61 and should reach $11 million by the end of FY '62. Over 80% of these contracts are with small business.

Systems workload for FY '61 encompassed 80 separate cases totaling $400 million. By the end of this fiscal year 100 cases are projected for a total of $1 billion.

P&P employs the Quick Reaction Contract only to a limited degree. These are time and service contracts averaging $10-15 thousand/year. It also makes use of blanket purchase orders for base procurement, awarded for three-month periods, to local contractors. Contractors are alternated on a periodic basis. ⌗

Vast future needs . . .

NORAD Uses Space Know-how to Defend U.S.

Command's SPADATS system designed to detect and track satellites; advanced plans include manned orbital craft

NORAD (North American Air Defense Command) has the mission of protecting the continental U.S. from aerospace attack. It carries out no direct procurement. This is accomplished through other Air Force agencies such as AFSC's Electronics Systems Division.

While NORAD performs no R&D, it does exercise its right to recommend or veto aerospace defense systems on the basis of compatibility and needs.

The next step beyond the problem of defense against ICBM's is that of defense against hostile satellites or other orbital weapon systems.

Since last July, NORAD's Space Detection and Tracking System (SPADATS) has been in operation at Colorado Springs, Colo. The total system is designed for satellite detection, tracking, orbit computation, and prediction.

At the present time, it consists of the SPADATS center, the Navy's Space Surveillance System (SPASUR), the Air Force series of space track radars across the continent, and inputs from certain Army centers, non-military scientific centers, and BMEWS.

Continued growth and updating of the system is provided by Electronic Systems Division's Space Track program (496L).

In time, it is expected that the *Saint,* or *Satellite Inspector,* program will provide additional inputs to the centers. These satellites will report to ground stations which in turn will feed data to NORAD.

• **Forward planning** — For the future, advanced planners at NORAD see aerospace defenses including both manned orbital vehicles and surveillance systems offering global coverage.

For the period 1970-1975, Lt. Col. T. M. Scott, chief of NORAD's Directorate of Future Plans and Advanced Developments, sees a definite place for military manned space vehicles.

A manned orbital system, said Scott, will be completely self-contained. It will have all the subsystems required to perform the basic aerospace defense missions of detection, identification, interception, and destruction in space.

Space defense requirements of the future, Scott asserts, include covering the entire volume of space from the earth's surface out to all satellite altitudes of possible interest.

To achieve such a total system, Scott said the following machinery would be required:

—*Midas*-type early warning satellites to supply the information necessary to alert the defensive systems and warn the nation.

—Sensors, both surface-based and satellite-borne, to provide identification of warheads and determine whether there is hostile intent.

—Orbiting interceptor systems which can intercept and destroy ICBM's in flight.

—Terminal-phase surface-to-air missile defense in a few vital, nonexpendable, hardened locations.

The control center, into which all data will be funneled, will be the NORAD underground combat operations center (COC) which is now under construction.

Scott further explained that NORAD COC will have secure, reliable data links and communications channels to and from all elements of an aerospace defense system. Automatic data-processing from high-capacity equipment will enable the commander to control his aerospace defense forces. Data will be channeled instantaneously into NORAD COC for all elements of the surveillance system, and will be available in simplified visual displays. ⁂

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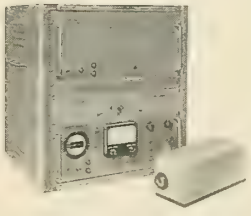

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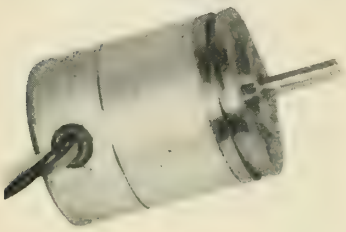

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Outline of History of USAF Man-in-Space R&D Program

16 February 1956—*Manned ballistic rocket research system development conceived and proposed, based on use of ICBM to put man in orbit by 1960. Hq ARDC memo.*

March 1956—*Specific attack on the problem of recovering a manned capsule from orbital conditions established by task 27544-7969 entitled "Manned Ballistic Rocket Research System." Interest was generated with some contractors who began a study effort that has continued to the present time.*

December 1956—*Unsolicited proposals for paid study efforts received from AVCO and Martin. Proposals were evaluated.*

April 1957—*Purchase Request prepared to initiate paid study with AVCO, but no funds were provided.*

4 November 1957—*Industry in-house study effort continued and so a study SR (172) was published to enable ARDC support.*

15 January 1958—*Seven unsolicited industry proposals to develop this vehicle had been received by ARDC. Technical evaluation of all concepts was initiated. NACA observers participated.*

24 January 1958 — *Memorandum from Mr. Horner presented to Mr. Holaday, OSD, covering recommended USAF Astronautics Development Program. The Manned Capsule Test Systems was a keystone. It was urged that special emphasis be placed on getting man into space at the earliest practicable date.*

31 January 1958—*Hq USAF letter signed by General Putt directed ARDC to determine quickest way to put man in space, and recover him; and forward information by 15 March.*

31 January 1958—*General Putt also sent letter to Dr. Dryden, NACA, inviting NACA to participate in the USAF planned development in a manner similar to the X-15 arrangement.*

Early February 1958—*NACA verbally informed ARDC their people were preparing their own manned capsule designs to be ready late March and they could not coordinate with the USAF Program before that. Hq USAF was so notified by 5 March letter signed by General Anderson.*

27 February 1958—*General LeMay directed in writing that a plan for an AF Man-in-Space Program be submitted to him as soon as possible.*

28 February 1958 — *Memorandum for the Secretary of the Air Force from Roy Johnson, ARPA, "recognized the Air Force has a long term development responsibility for manned space flight capability with the primary objective of accomplishing satellite flight as soon as technology permits." He "authorized development of a test vehicle for experimental flights with laboratory animals, in furtherance of the objective of manned satellite flight."*

7 March 1958 — *Letter dated 7 March from General Boushey reaffirmed ARDC evaluation due date to 14 March and still to obtain maximum possible NACA collaboration.*

14 March 1958—*Recommended Air Force Manned Space Systems Program forwarded to Hq USAF. Included was the Abbreviated Development Plan for a manned capsule which provided for 1st flight in Mid-1960. NACA participated in the preparation and concurred in the solution.*

April 1958—*ARDC task force prepared the Development Plan for Man-in-Space-Soonest. (MISS) based on use of the THOR booster plus a fluorine engine second stage with 1st manned flight, October, 1960. Also, General Flickinger made arrangements with AFBMD concerning inclusion of animal experiments in 117L flight test program.*

11 April 1958—*NACA (Dr. Dryden) signed agreement to do joint MIS program with USAF in manner similar to X-15.*

2 May 1958—*MISS Development Plan submitted to Hq, USAF and ARPA.*

8 May 1958—*Mr. McIntire and Mr. Horner, Office SECAIR, phoned Gen Anderson; said can't finance all 1st year MIS program—only $67 million available ($47 ARPA plus $20 million NACA). Development Plan revised.*

12 May 1958—*Letter from General LeMay to General Anderson directing evaluation of the AVCO-Convair proposal as a possible quicker, cheaper, less complex method.*

20 May 1958—*Letter from General Anderson to General LeMay stating evaluation revealed AVCO-Convair proposal offered lower probability of providing a successful early MIS program than 2 May 1958 USAF plan. Recommendation: buy USAF.*

21 May 1958—*Mr. McIntire, Asst Secy AF, directed revising MISS Development Plan to use ATLAS instead of the THOR-Fluorine booster, to help reach earlier manned flight.*

29 May 1958—*ARPA gave MIS briefing to Nat'l Security Council Planning Group.*

12 June 1958—*General Boushey phoned that ARPA authority for ARDC to proceed with MISS had been issued subject to Presidential approval, which has been solicited. NACA coordination has been received. ARPA also requested consideration be given to use of ATLAS plus HUSTLER engine booster as an alternative approach.*

16 June 1958—*ARPA approval obtained to proceed with study contracts on the ecological aspects of the MISS capsule, up through mock-up.*

23 June 1958—Two 3-month contracts *(total $340,000) let to NAA and*

GE for Phase I of ARDC Life Support System Development (design study of space cabin and internal ecological subsystems).

24 June 1958—*Conference held to try to reach agreement on MISS Program. ARPA, USAF, and NACA. STL, Convair and Lockheed representatives participated and argued for a different technical approach—no detailed go-ahead agreement was reached. Funding discussed is now $33 ARPA and $33 NACA (millions). Good AF support from Gen Boushey.*

8 July 1958—*Gen Boushey phoned and related that there is a serious difference of opinion between the DOD, the BOB and the White House regarding who has cognizance of the National Space Program. BOB is firmly for NASA. MISS Program might be reduced. Nothing can be done to release funds for go-ahead on crucial items due to the above dispute.*

25 July 1958—*New MISS Development Plan based on ATLAS submitted to ARPA. Mr. Johnson stated: no approval, AF would have to negotiate with NASA and NASC, FY 59 fund level probably only $50 million, and White House questioning the merit of manned space flight at this time.*

29 July 1958—*President signed bill to establish NASA.*

12 August 1958—*MISS conference with ARPA, NASA, USAF, ARDC held on MISS. Agreement reached that: There should be one Development Plan based on $40 million FY 59.*

20 August 1958—*Gen LeMay sent letter to ARDC. President made decision to assign MISS to NASA. ARPA MISS funds also transferred to NASA, FY 59 funding now $40 million (ARPA $10 and NASA $30), and "soonest" ground rule eliminated.*

2 September 1958 — *AFDAT reported the BOB had overridden Mr. McIntire's decision to fund the AVCO proposal through re-programing if not supported by ARPA.*

9 September 1958—*Meeting with ARPA. ARPA desires to justify MIS as a military requirement with relations to Dyna Soar III.*

18 September 1958—*Hq ARDC letter to Hq USAF containing results of evaluation of revised AVCO proposal: no change but interested in technical development of certain aspects.*

18 September 1958 — *Revised ($40 million) MISS Development Plan submitted ARPA/NASA. $12.5 million was requested for immediate go-ahead. No decision could be made until 24 September 1958 Space Council meeting.*

24 September 1958—*Space Council meeting. No decisions. President indicated difference would be resolved by Military Liaison Committee.*

Late September 1958—*Information received that NASA is developing a Life Support Capsule. No indication of part USAF will play.*

Early October 1958—*Discussions occurred with NASA with regard to ARDC help in the NASA balloon part of their MIS Program.* ⁂

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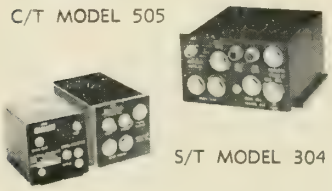

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Executive for Small Business: *Mr. John C. Eiden*
Mail Symbol: *SCMK-2—Ext 6331, 6107*
Contractor Relations and Procurement Sources: *Mr. LeRoy E. Olson*
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Electronic Systems Division
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Interests are: *Complete acquisition program for electronic systems.*

Aeronautical Systems Division
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Tel: CLearwater 3-7111 (Dayton)

Small Business Specialists: *Mr. George Rattenbury and Mr. Larry Grier*
Mail Symbol: *ASRKB—Ext 38216*
Contractor Relations and Sources: *Miss Betty Weisbrod*
Mail Symbol: *ASRKB—Ext 39250*

Interests are: *Complete acquisition program for aeronautical systems and applied research in guidance systems for aircraft and missiles, etc., flight control, propellers and rotors, testing including aerodynamic, structural and environmental tests, powerplants, ground equipment, aeromedical equipment (aerial reconnaissance), airborne equipment, aeromedical equipment, human factors research, airborne electronics equipment, materials, aeronautical science research, including chemistry, mathematics, physics, fluid dynamics, mechanics, and system dynamics. Aircraft and missile systems components. Aerodynamics, including instruments, structure, design, dynamics control and propulsion.*

Deputy Commander For Aerospace Systems
Air Force Unit Post Office
Los Angeles 45, Calif.
Tel: ORchard 0-1444

Smaill Business, Contractor Relations and Sources: *Mr. Roy A. Watkins*
Mail Symbol: *DCMB—Ext 1005*
Interests are: *Acquisition of missile and aerospace systems.*

San Antonio Research and Development Procurement Office (Div. of ASD)
P. O. Box 63, Lackland AFB, Tex.
Tel: WAlnut 3-3411

Small Business, Contractor Relations and Sources *(Miss W. Bell)*
Mail Symbol: *WWKLS—Ext 2113/2564*

Personnel Laboratory interests are: *Research into personnel resources, operator research, social sciences, aviation medicine and related problems, cold environmental research, etc.*

Air Force Flight Test Center
Edwards AFB, Calif.
Tel: CLifford 8-2111 (Town of Edwards)

Small Business Specialist: *Mr. James L. Thompson*
Mail Symbol: *FTKC—Ext 29461*

Interests are: *Testing of new aircraft systems, research aircraft, aircraft components, flight test instrumentation, rocket propulsion and parachutes.*

Air Force Special Weapons Center
Kirtland AFB, N.M.
Tel: CHapel 7-1711 (Albuquerque)

Small Business Specialist: *Mr. M. H. Nickerson*
Mail Symbol: *SWKSB—Ext 2153*
Contractor Relations and Sources:
Mail Symbol: *SWKSR—Ext 2093*

Interests are: *Research, development, test, and evaluation of Air Force components of equipment related to atomic weapons.*

Air Force Missile Test Center
Patrick AFB, Fla.
Tel: ULysses 7-6151 (Cocoa Beach)

Small Business Specialist, Contractor Relations and Sources: *Mr. Richard McCoy*
Mail Symbol: *MTKSA*

Interests are: *Test range instrumentation involving radar, trajectory computers and recorders, tracking and target analysis, wire communications, radio communications, programing timing and firing systems, telemetry receiving, data storage, data reduction.*

Rome Air Development Center
Griffiss AFB, N. Y.
Tel: FF 6-3200 (Rome)

Small Business Specialist, Contractor Relations and Sources: *Mr. John Vella*
Mail Symbol: *RAKS—Ext 5220*

Interests are: *Radar communications, navigation, electronic warfare, intelligence, support equipment for radar and communications, specialized support, including human engineering and technical writing, guided missiles, including aerodynamics and ballistic guidance control, handling and launching and propulsion.*

Air Proving Ground Center
Eglin AFB, Fla.
Tel: Eglin 2231

Small Business Specialist, Contractor Relations and Sources: *Mr. J. V. Leftwich*
Mail Symbol: *PGKS—Ext 672842-672843*

Interests are: *Research, development, test and evaluation of guns and other aircraft weapons, ammunition, rockets, bombs, and fire control components and systems.*

Air Force Missile Development Center
P. O. Box 939
Holloman AFB, N. M.
Tel: GRanite 3-6511 (Alamogordo)

Small Business Specialist, Contractor Relations and Sources: *Mr. D. P. Hathcock*

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Mail Symbol: *MDKS—Ext 6861*

Interests are: *Guided missiles—conduct of research and development of guided subsystems and components. R&D in the field of human factors, including biodynamics and space biology.*

Arnold Engineering Development Center

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Small Business Specialist, Contractor Relations and Sources: *Mr. J. Moriarty*
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AFSC Regional Office, *Tel: FInancial 6-9181. Rm 715, La Salle Building, 39 South La Salle Street, Chicago 3, Ill.*
AFSC Regional Office, *Tel: OXford 6-3594. c/o Department of the Navy, Room 2305, Munitions Building, Washington 25, D. C.*
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AFSC Liaison Office, *Massachusetts Institute of Technology, 68 Albany Street, Cambridge, Mass.*
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(Continued on page 153)

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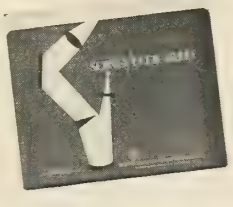

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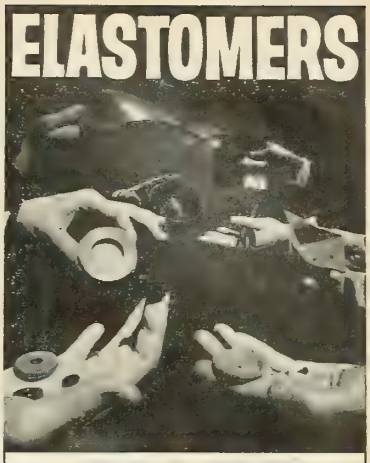

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Outlook for the Military in Space

TWO NEWS EVENTS in the Soviet Union emphasize the importance of recent military testimony before Congress. The launching on March 16 of another *Sputnik*, together with Premier Khrushchev's simultaneous boast of a global rocket, point once more to the compelling reasons behind the current Air Force drive for a larger space effort.

This issue is devoted to the funding, programs and facilities for U.S. military space systems. When viewed as a single package, as it is here for the first time, the military effort devoted to this area becomes impressive.

Already, the annual military space budget is approaching $1.5 billion. In the light of programs now nearing or in the advanced development stage, the estimate of an annual military space budget of over $6 billion by 1970 is conservative.

Industry and Air Force research and development for space is, in many areas, well ahead of Department of Defense thinking.

We are deeply concerned with DOD's reluctance to acknowledge the urgent need for an effective U.S. space force. Such a force is needed for control of what President Kennedy has described as a new ocean.

It is axiomatic in history that the nation which wants to carry out peaceful trade and transit over an ocean must be able to dominate that ocean with its military forces. What will we do the first time a Barbary pirate of space knocks down one of our satellites or captures one of our orbiting space stations?

That day may not come. But it is much more likely to come if we are not prepared for it—and it could come much sooner than some influential people are willing to admit.

We think Assistant Defense Secretary John Rubel, who is responsible for management of DOD space programs, is a frank, engaging and sincere public servant. We just flatly disagree with his views on the military space role.

There are several soft areas in our development of military space systems which are causing concern to knowledgeable U.S. military leaders today.

The *Dyna-Soar* program should be stepped up immediately. The project is basic to the development of a capability for winged re-entry from orbit. This is the alternative to ballistic re-entry, which one Air Force officer describes as comparable to dumping a Boeing 707 in the ocean after flying it from California to New York.

The Air Force must have a capability to take off from and return to predetermined landing areas. *Dyna-Soar* will provide advanced technology for that capability. Both military and scientific manned orbital laboratories will require a crew ferry to and from the station. A winged re-entry vehicle offers more promise for that mission than a ballistic vehicle.

Military leaders and responsible industry scientists and technicians close to the *Dyna-Soar* project say it can be accelerated with additional funding. John Rubel says that it cannot be and should not be. We think he is wrong.

Development of large solid boosters has been slowed to an exploration of advanced technology. DOD and NASA officials explain that results of static tests of 100-inch solid boosters cannot be extrapolated to boosters of 156 inches and larger. They conveniently ignore similar jumps in liquid technology while overriding competent testimony from industry and Air Force officials.

We side with those who think development of large solids can and should be pushed at a faster rate. Large, quick-reaction boosters are essential to upcoming military space programs. To wait until a specific military mission appears is like waiting to develop an aircraft engine after you have invented the airplane.

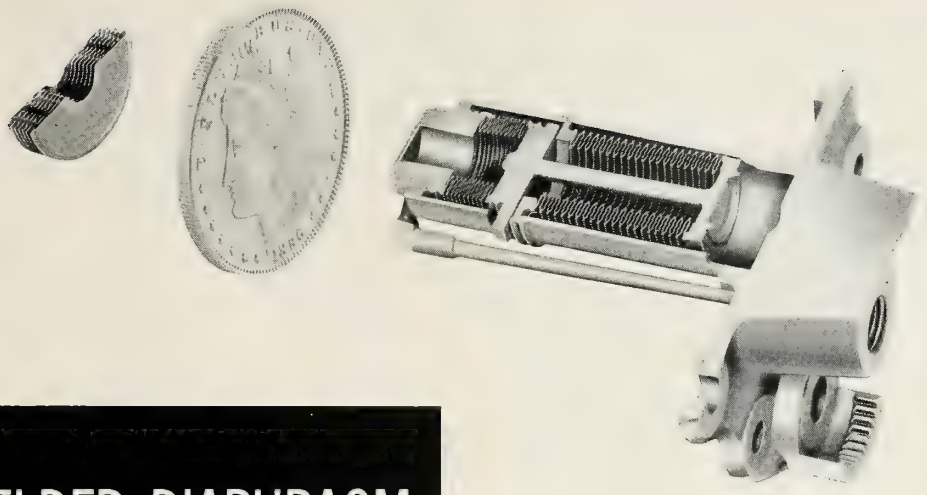
Communications satellite development is another muddled area for which DOD can be held largely responsible. Poor planning and interservice politics are slowing development of the effective command and control network which is a must for military space operations.

ON BALANCE, however, the prospect is heartening. Successful firing of the *Titan II* and budget planning for *Titan III* are encouraging and offer hope of more emphasis for *Dyna-Soar*. Integration of Air Force and NASA efforts in the rendezvous and lunar programs is a large step forward for military space programing. The *Discoverer* program is an outstanding success and its two snooping offspring—*Samos* and *Midas*—are adequately funded.

Congress is becoming increasingly aware of the need for military operations in space, both manned and unmanned. And the Administration seems to be learning that it must lend a military emphasis to its purely scientific space program to obtain full backing from the Hill.

These signs all bode well for the military space systems discussed in this issue.

William J. Coughlin



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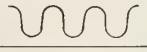
1. Diaphragm Shape		
2. Effective Area	±4%	±1%
3. Spring Rate	±20%	±10%
4. Materials	Ductile metals	All weldable metals
5. Life	Erratic	Predictable and consistent
6. Stroke to solid height ratio	1/1	3/1 to 10/1 Depending on OD – ID relationship
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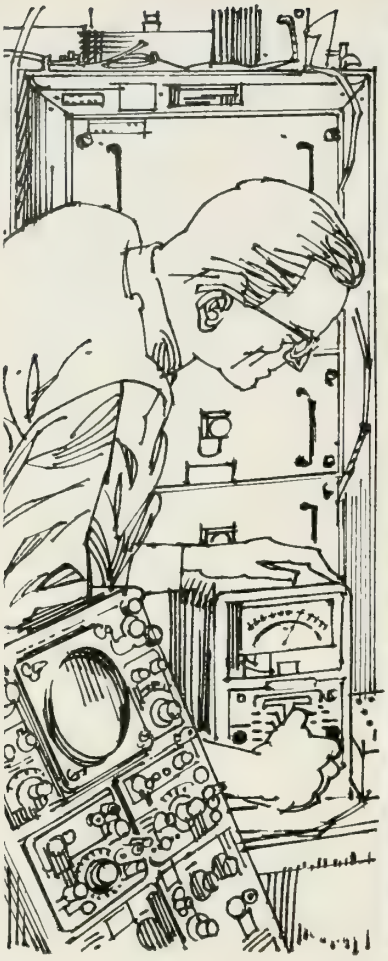

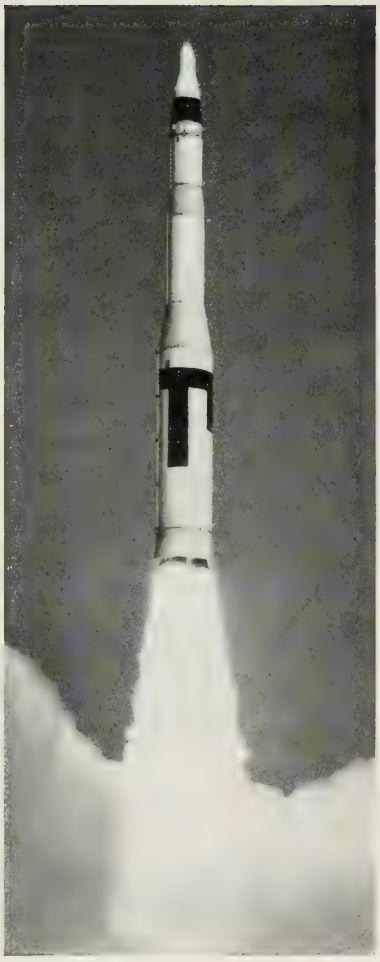

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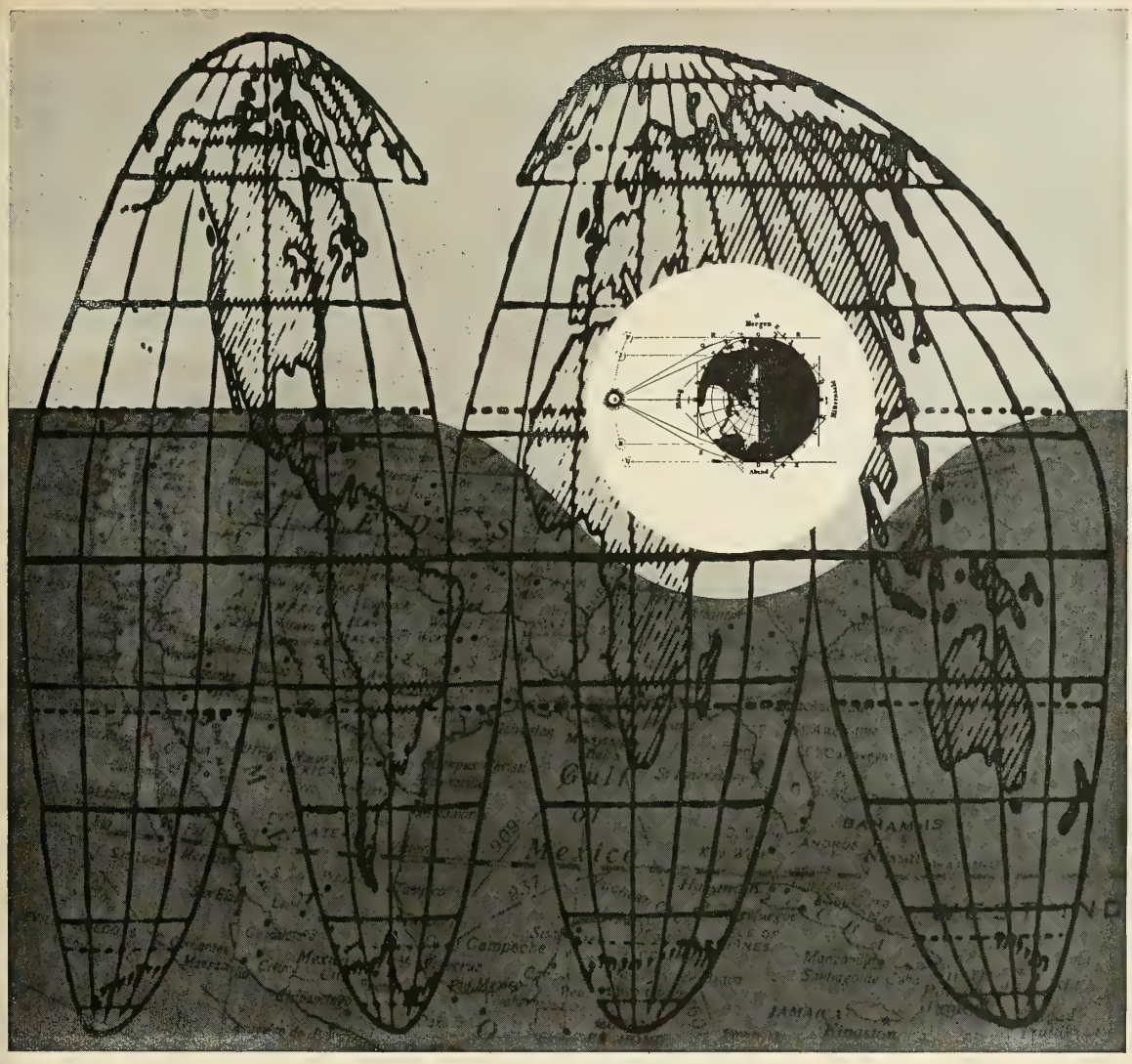

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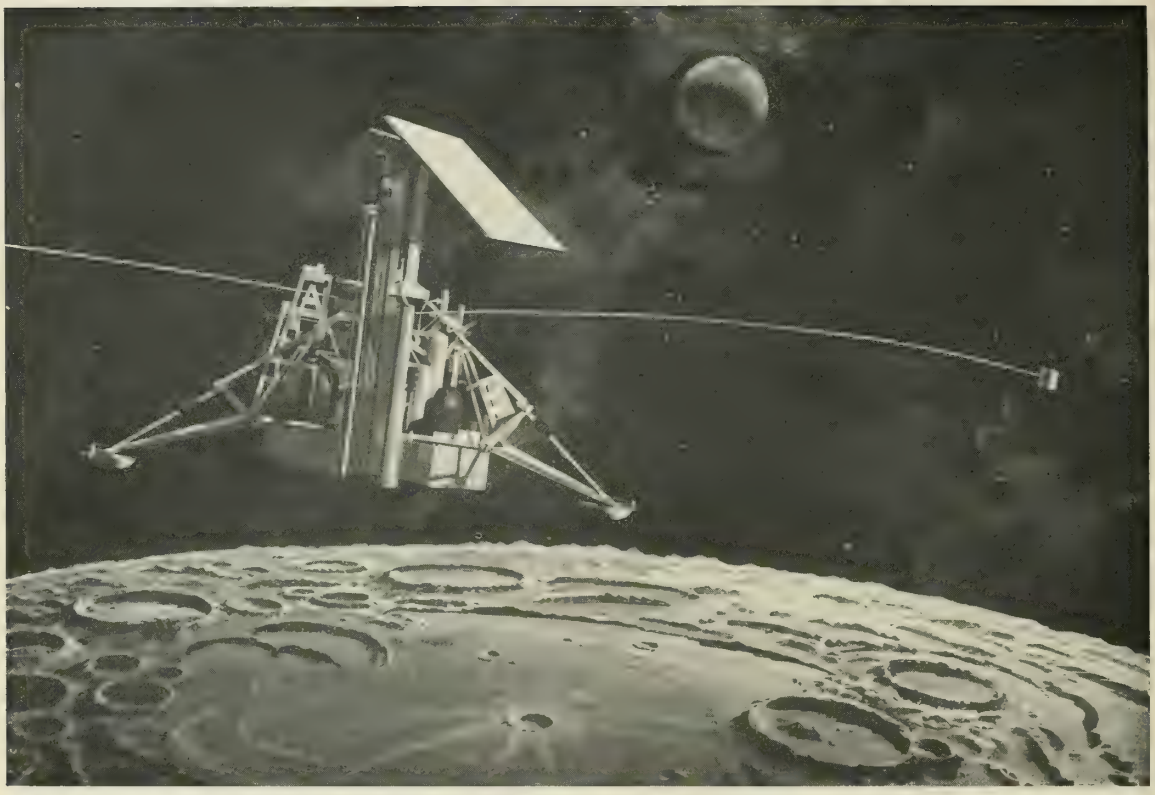

Soft land this vehicle on the moon

This spacecraft is SURVEYOR, one of the many important projects now under way at Hughes. It will "soft" land on the moon sometime in 1963. Its mission: to pierce and analyze the moon's surface; to transmit back to earth high quality television pictures; and to measure the moon's magnetic and radiation characteristics. To accomplish these demanding objectives, Project Surveyor requires the talents of many imaginative junior and senior engineers and physicists to augment its outstanding staff. A degree from an accredited university and U.S. citizenship are required. Experience in Aerospace Vehicles is preferred but not necessary. A few of the openings include:

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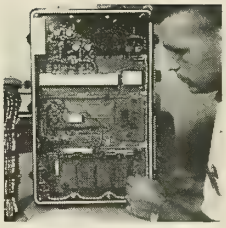
THE COVER

Minneapolis-Honeywell engineer gives final check to unit combining pulse rebalance, gyro torquer and power supply for airborne portion of highly sophisticated inertial guidance for NASA's Centaur. *See p. 22.*



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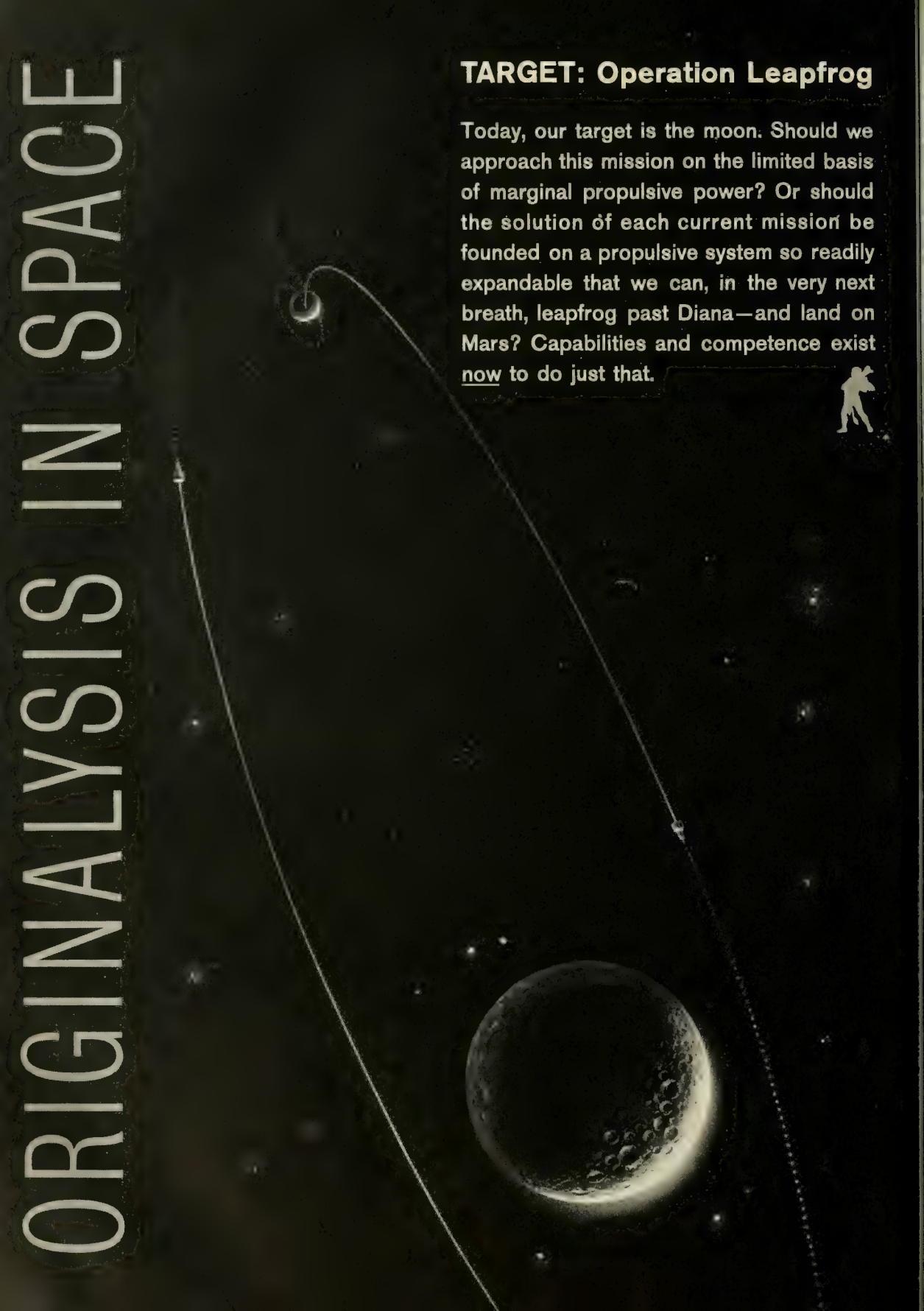

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letters

The Patent Debate

To the Editor:

Your Feb. 26 issue carried a letter headed "Small Business Apathy?", signed by Louis L. Orenbuch of Boston.

We take violent exception to the writer's objection to the DOD policy of permitting military contractors to retain commercial rights in inventions. His premise that most of the Department of Defense R&D goes to big business is very probably true. However, there is no single large development contractor who does not include a great many property parts owned and developed by small business subcontractors. If DOD is forced to change its policy of allowing contractors to retain their patent rights, this will also force them to require of subcontractors all patent rights, proprietary rights and know-how—and will be most injurious to small business.

I have no idea what business Mr. Orenbuch may be in, but most evidently he cannot be in the business of filling defense contracts, on either a prime or a subcontracting basis. As an alternative, if he is in the defense, he most obviously does not have the brain power at his disposal to develop any patentable items of his own.

D. L. Leavitt
President
AIRATERRA
Glendale, Calif.

To the Editor:

Re: Patents and their relation to the individual, the company and the government.

The case in point is where the individual has assigned his rights to claims for patent to the company for monetary or other considerations, and the company in turn has used the assignment in the production of goods that have been sold to the government.

This, then, has set the precedent for the relationship the government can assume with the company (an assignment of claims of patent corresponding to that between company and individual).

There is only one way to correct this situation to protect the rights of the individual: remove all assignment agreements —past, present and future—between the individual and the company, and replace them with licensing agrecments for the right to manufacture. Since the government is not directly involved in the manufacturing business, the individual's benefits from his claims of patent will be protected.

The licensing agreements should be in two parts: first, an agreement of intent to license prior to awarding the claims of patent; second, the actual licensing agreement after awarding of claims of patent.

N. A. Norene, Owner
Engineering Service Co.
Seattle

Space Catharsis

To the Editor:

Mr. Saunders B. Kramer's letter criticizing those who would oppose man's direct exploration of space (M/R, March 5) might also have included one of my pet irritations.

During the past 5 years that I have been doing research on astronomical problems for industry, and consulting with various authorities, I have become thoroughly dismayed with the confusing array of controversial data and opinionated writings of our more prominent members of the astronomical hierarchy who often vehemently disagree with each other on many facets of their kindred works.

No greater evidence of this can be obtained than the opinionated papers I have studied involving the nature of the lunar surface and its physiography—not to mention such a subject as What Is A Comet?—a matter that is tossed around by the theoreticians without much agreement.

The striking and real difference between today's youthful scientists and our older theoreticians (*academicians,* to use a Russian term) is that today's scientists are empiricists, a pragmatic lot who *must be shown.* For example, we want to analyze the lunar surface *directly,* for by no sophistry of the imagination can we ever really know the true nature of the moon . . . until we explore first-hand.

It has been the lack of laboratory equipment, namely space probes with instruments, that has kept astronomy largely on the theoretical side. We had no idea of a Van Allen Belt until we orbited satellites. We theorized that perhaps the earth's magnetic field did trap particle radiations from the sun, but we had no idea of the intensity, frequency or distribution of these radiations . . .

Future astronomical papers will be far more objective in content and extrapolations—which is perhaps why many theoreticians are opposed to the direct exploration of space by man. Their precious theories might be completely squelched—these scientists who now write and act as though they assisted God with the creation of the Universe!

I want to see man explore space, not only for the sake of knowledge and material application, but for philosophic reasons. When the first airplane lifted from the ground, the Tower of Babel fell. What other myths and dogmas might fold when man begins to directly explore the cosmos? The necessary revisions of our social behavior, moral attitudes and religious thinking might take on the effects of mental purgatives—cleaning us and bringing mankind a little closer together. But, as T. Huxley said of scientific truths, the yet-to-be-learned ones may "sear the eyeballs."

Ray Benton
Baltimore

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The Countdown

WASHINGTON

GAO Says McDonnell Contract A-OK

Government Accounting Office has given the NASA contract with McDonnell Aircraft Corp. for the *Mercury* capsule an A-OK rating. The capsules cost twice the original estimate of $400 million. The review is the first result of a GAO step-up in monitoring of NASA contracts.

Centaur Launch Slips Further

First launch of *Centaur* now is set for April 6. Slippage of another week followed a systems integration checkout of the *Atlas*-based upper stage prior to its scheduled March 29 firing. Second launch of the *Saturn* booster now is set for April 23. Further slippage in both programs is expected. (For *Centaur* guidance story, see p. 22).

A Week Away in Space

Crewmen on the first *Gemini* rendezvous flight are expected to be in orbit about a week. NASA says the long-duration flight probably will be required in order to launch the *Agena B* vehicle in the time period and precise orbit needed.

NASA Construction Spending Up

NASA will spend well over $500 million annually on new construction for the next four or five years, according to the Army Corps of Engineers. Biggest job will be the Mississippi Test Facility, where five test stands in the 4-to-5-million-lb.-thrust class, four stands in the 12-million-lb. class, and two stands in the 22-million-lb. class will be built.

Small AF Office in NASA Liaison

The liaison office which Air Force Systems Command is setting up to work with NASA's Manned Space Flight Project Office on the lunar program will have a staff of 25, including one general officer and nine senior officers.

Those Skyrocketing Skybolt Costs

Cost of *Skybolt* ALBM program, originally estimated at $170 million, now is closer to $493 million. (M/R, March 12, p. 9). Defense Secretary McNamara admitted to the House Defense Appropriations subcommittee that he was "very embarrassed" to see costs rise far above estimates. He assured the committee DOD is giving considerable attention to improvement of cost estimating procedures.

Army Planning Missile Air Cavalry

Army officials are moving quickly to create missile-equipped helicopter-borne "Air Cavalry" units capable of offensive action against ground targets. The first unit, being formed at Fort Knox, Ky., will have a platoon of helicopters equipped with machine guns, rockets and wire-guided antitank missiles.

INDUSTRY

INS Passes Rugged Shock Test

The Inertial Navigation System in Fairchild Stratos' *AN/USD-5* high-performance drone was recovered from the rubble following a booster explosion which destroyed the drone on launch early last month at the Yuma Test Range in Arizona. Shipped back to the Minneapolis-Honeywell Aero Division plant at St. Petersburg, Fla., it has been thoroughly checked out and will be used again. Only reported damage: that suffered by the computer input/output unit and the exterior finish on electronic subsystems.

Ranger Set to Try Again

Ranger IV lunar-landing mission is scheduled for launching from Cape Canaveral late this month. One significant change since the last attempt: an automatic ground control switch will be used to back up *Atlas* engine cutoff. It is hoped this will prevent the long burning time which marred the *Ranger III* flight in January.

Scout Launch Equipment Delivered to PMR

Launch equipment for the firing of *Scout* from the Pacific Missile Range has been delivered to PMR by Ling-Temco-Vought. To be used in support of both AF and NASA launches, the equipment is expected to support launches as frequently as twice a month—thanks to an improved assembly and checkout system.

Disagreement Delayed Titan III

Industry sources say a NASA-DOD disagreement delayed initiation of the *Titan III* space booster program for a period of three to four months. NASA was seeking what has been termed a *"Titan 2½"* while DOD was holding out for *Titan III*. Due to the joint launch vehicle agreement of last year, neither could proceed without the written consent of the other.

INTERNATIONAL

International Satellite Shots Upcoming

NASA's international satellite program will move into high gear this month with the launch of the *S-51* satellite set for April 10. Following in mid-1963 will be the *S-52* satellite for which Westinghouse recently was awarded a $1-million contract. Both satellites are being launched in cooperation with the United Kingdom and both will conduct scientific measurements of various space phenomena.

Manned Space Vehicle Studied in UK

Britain's Ministry of Aviation, Ministry of Defense, Air Ministry and Bristol Siddeley Engines Ltd. are working on design for an *Aerospace plane*-type manned space vehicle. Technical studies, including wind tunnel tests, have been carried out at the Royal Aircraft Establishment, Farnborough. Gas turbines would be used for vertical takeoff with advanced ramjets taking over for acceleration to half-orbital speed. Rocket engines then would be employed for the space mission.

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The Missile/Space Week

Space Pact Efforts Start

First concrete efforts toward U.S.-Soviet space cooperation were under way in Geneva last week while secrecy shrouded early talks at the United Nations.

Dr. Harry Wexler, Director of Meteorological Research for the U.S. Weather Bureau, is in Geneva preparing for a May 29 meeting of the World Meteorological Organization. A top Russian scientist, like Wexler a member of the WMO secretariat, was in the same city helping to lay the groundwork for the meeting.

Informed sources report the U.S. and USSR representatives are also discussing cooperation in the weather satellite area.

In New York, members of both delegations were tightlipped last week regarding exploratory talks between NASA's Dr. Hugh L. Dryden and Dr. Anatoli A. Blagonravov of the Soviet Academy of Sciences.

The bilateral discussions are aimed at detailing the seven areas of possible cooperative space efforts proposed by President Kennedy in recent correspondence with Premier Khrushchev.

The UN's 28-member-nation committee on outer space was meeting at the same time.

AF Shifts Rumored

Air Force has denied reports that Secretary Eugene M. Zuckert and Chief of Staff Gen. Curtis LeMay will resign or retire soon.

Several other shifts in a top-level AF reorganization are said to be in the offing:

- Assignment of Maj. Gen. O. J. Ritland, commander of the Space Systems Division in AF Systems Command, to AFSC headquarters as Deputy Commander for Manned Space Flight within the "next 30-45 days."
- Upgrading of SSD to the level of an Air Force, with consequent increases in power and prestige. The new Air Force would be called "The Military Space Force."
- Assignment of Lt. Gen. H. M. Estes, presently Deputy Commander for Aerospace Systems in AFSC, to replace Gen. Ritland if SSD is upgraded. Otherwise, Estes is expected to be assigned to a space program post in the Pentagon.

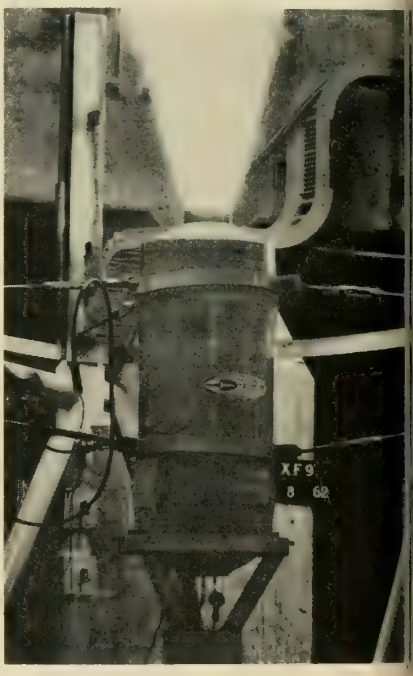
The changes are said to have been discussed at a meeting at Ramey AFB, Puerto Rico, called by Gen. LeMay early in March.

The Air Force declined to confirm or deny the changes, under its policy of not announcing personnel or organizational changes until they take place.

Shots of the Week

President Kennedy became the first U.S. chief executive to see an ICBM launched when he watched an *Atlas* fired from Vandenberg AFB on March 23.

In an operational readiness firing the Convair *Atlas* successfully reached its target in the Pacific Ocean. It impacted eight-tenths of a mile from its predicted impact point.



UTC Filament-wound Test

UNITED TECHNOLOGY CORP. demonstrated practicality of large segmented filament-wound motors with successful firing of 12,000-lb.-thrust glass-wrapped, three segment rocket. Walls were cool to touch after 12-sec. test in UTC-wound case assembly. No details on joints were disclosed, but process does not involve metal-to-glass bonding. Nozzle is inside top portion of case in this photo. Test engine was 5 ft. long and 2 ft. in diameter.

• *Minuteman* scored its seventh consecutive success March 23 when it was launched from its underground silo and impacted more than 4000 miles downrange from Cape Canaveral.

Objectives of the first night flight of the solid-fueled Boeing ICBM were to evaluate silo environment and launch characteristics of the operational configuration.

• A biological package was successfully launched and recovered in the nose cone of a meteorological rocket March 16, Pacific Missile Range authorities reported. Purpose of the test was to determine the effect of primary cosmic radiation on living matter.

• NASA launched two sodium vapor rockets from Wallops Island to study atmospheric effects at high altitudes.

Avco To Make Apollo Shield

Avco Corp. will design and build the heat shield to protect the crew of the *Apollo* spacecraft from re-entry heating.

Selection of Avco for the contract—expected to exceed $8 million—was announced by North American Aviation's Space and Information Systems Division, principal *Apollo* spacecraft contractor for NASA.

Avco President James R. Kerr said that charring plastics will be used in the heat shield. The *Apollo* will re-enter the earth's atmosphere at approximately 25,000 miles per hour after taking the first Americans in scientific exploration to the moon.

Senate ComSat Bill Emerges

Administration officials have voiced general approval of a Senate bill to set up a commercial communications satellite system.

The measure was reported by the Senate Space Committee and is up for public hearings before the Senate Commerce Committee.

The compromise legislation includes the provision deemed most important by the Administration—broadly based ownership. Fifty percent of the common stock would be owned by U.S. communications carriers; the rest would be sold only to the public, except that foreign governments might buy a total of 20%.

Correction

On p. 9 of the March 19 issue, MISSILES AND ROCKETS *inadvertently referred to the Rocketdyne M-1 engine. Contract for the M-1 engine is, of course, held by Aerojet-General Corp.*

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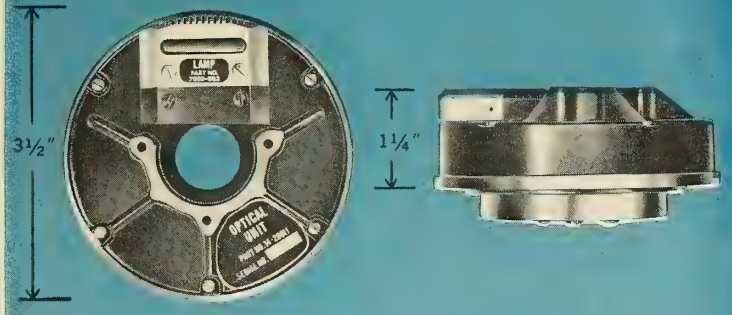

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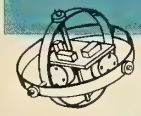

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New hearings set...

Congress Probes NASA-AF Disputes

Two agencies are sharply at odds over location of Titan III pads and pace of funding for big solids

by Hal Taylor

CONGRESS is turning its gun on two sharp NASA-Air Force disputes—over the Atlantic Missile Range and more funding for large solid booster development.

The AMR disagreement concerns location of the Air Force's launch complex for the *Titan III* booster.

The Air Force wants to build the three *Titan* pads in the new NASA land acquisition at Cape Canaveral between the space agency's *Advanced Saturn* and *Nova* launch facilities.

NASA has nixed the idea.

Instead, it has proposed that the pads be constructed behind the moon launch complexes—even though the location would present "over-flight" problems.

Reportedly, the chances for settling the dispute in the near future are unlikely. This could mean a real delay in both agencies' space programs—in which launch facilities are the pacing items.

The disagreement was revealed when a House Space Subcommittee ordered a closed-door executive session to delve into the problem. Slated to testify were Gen. Bernard Schriever, Commander of the Air Force Systems Command; Dr. Robert C. Seamans, Associate NASA Administrator; and D. Brainerd Holmes, Director of NASA's Office of Manned Space Flight.

The hearing was scheduled following a subcommittee field trip to Cape Canaveral.

"We found," one subcommittee member told M/R, "that we need more firing sites than we've got room for."

Some people (NASA and certain other scientists) feel that "over-flights" are necessary if all the needed launch facilities are to be built at AMR.

Air Force officers contend that overflight by the giant *Titan III* boosters would present almost impossible safety problems. In addition, it is believed that the *Titan III* fuel would be toxic and thus have a corrosive effect on any building or equipment over which it flew.

The basic NASA position is that it does not want its two possible launch sites for the lunar landing mission split up. There is also a question as to whether there is enough room for all three facilities.

A proposal has been made to build NASA's large *Nova* pads behind the other facilities, apparently because these will be needed much later than the *Titan III* and *Advanced Saturn* sites.

• **Booster emphasis**—The problem of funding for the large solid booster development is not so much a dispute as it is a difference in emphasis.

The Air Force wants development speeded up. NASA is satisfied to put most of its eggs on large liquid engines for direct manned flights to the moon.

Schriever told the House Space Committee on Advanced Research and Technology last week that not enough money is being requested for large solid booster development in Fiscal '63.

He was supported by two top officials of Hercules Powder Co. and United Technology Corp.

The subcommittee requested that Schriever appear again before the committee this week. He is slated to tell the committee how much full-scale development of the large launch vehicles would cost. NASA, in turn, will be given an opportunity to state its position. Holmes and Milton R. Rosen, who directs NASA's large launch vehicle program, will probably testify.

Holmes last week kicked off detailed hearings on the manned lunar landing program when he told the Subcommittee on Manned Space Flight that Project *Apollo* would involve the participation of hundreds of thousands of Americans and thousands of U.S. firms. Other important testimony on propulsion technology was given by John H. Sloop, director of NASA's propulsion and power generation office.

• **Big picture**—In review of *Apollo*, Holmes said that:

—All engines required by the *Apollo* spacecraft will be under development this year.

—The service module will provide propulsion for take-off from the moon and return to Earth. It also will provide an abort and return capability at any time during the mission. For this reason, the service module propulsion must have the highest degree of reliability—99.9%—of any propulsive element in the system.

The lunar take-off propulsion will require a thrust of 20,000 lbs. It will be controllable over a wide range so that the unit can perform its various functions. The system will be pressurized and hypergolic.

—The lunar landing propulsion—which will use liquid oxygen-liquid hydrogen—presents a formidable challenge. Several engines will be employed to give the wide range of thrust that is demanded by the landing maneuver.

The lunar landing module is a rocket of substantial size, having a gross weight of 100,000 lbs.

It may be economical, therefore, to use pump-fed engines in order to avoid excessive weight in the fuel tanks. Thrust level is not critical and would lie in the neighborhood of 50,000 to 75,000 lbs.

—*F-1 engine* — One model of the engine has been run at full power at Edwards AFB. Much more testing remains to be done. Engine deliveries to NASA will begin in 1963.

—J-2 liquid hydrogen engine—Development began in 1961. The first complete engine is now fully assembled and tests started in February. First deliveries of ground-test engines are expected by mid-1963.

—M-1 liquid hydrogen engine—owing to prior experience with the J-2, no new technological development is required in the development of the M-1. It's expected that first deliveries of the engine will be made in 1964.

—Advanced *Saturn* booster — The first stage will be powered by five F-1 engines. Its tanks are 33 ft. in diameter and carry over 200 tons of liquid oxygen and kerosene. The first stage will be 140 ft. high.

The second stage will have five J-2 engines and will carry close to a million lbs. of liquid oxygen and liquid hydrogen fuel. It is 33 ft. in diameter and 70 ft. high. The third stage with one J-2 engine will be used only for escape missions.

—*Nova*—The giant launch vehicle

should be in full scale development in Fiscal '63 (see below).

• **Propulsion puzzles**—NASA's Director of Propulsion and Power Generation covered a whole range of propulsion problems, liquid and solid, before Subcommittee No. 2 of the House Space Committee.

The rocket expert pointed to some promising developments, in DOD's program on high-energy solid-propellant chemistry, which NASA keeps under close surveillance. Two propellants, containing boron, hydrogen and nitrogen appear to merit further work.

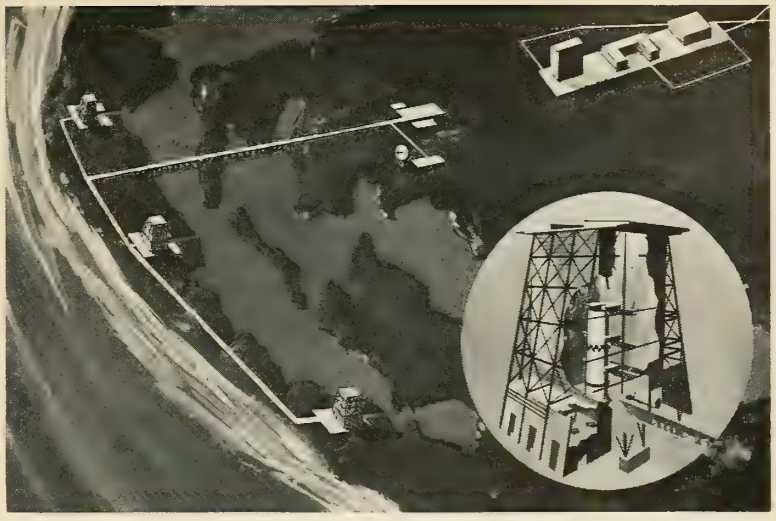
In liquid mono- and bi-propellants, DOD has come up with some promising combinations in C-H-O-N and B-H-O-F atomic species. Sloop said there are developments in solids which may increase performance by more than 18%. If this were applied to the *Surveyor* spacecraft, it would mean a 50% increase in instrument package weight.

Present solids approach a specific impulse of 300, and some under study may go as high as 400 in space applications. Liquids are now past the 400 mark in I_{sp} and may easily reach 500.

Sloop described a new construction technique for liquid engines which looks good to NASA. The concept is a radiation-cooled thrust chamber. NASA has fired chambers consisting of a shell of pyrolytic graphite about 0.005 in. thick. If these can be perfected, says Sloop, propulsion can be greatly simplified.

The chamber described was formed in one piece through mold deposition. This form of graphite increases in strength as the temperature rises.

A right-angle-firing solid-attitude control motor is under study. In this instance, it is a small end-burning motor rotating on two bearings and driven by an actuator through a sector gear. The nozzle is canted so the gases are directed nearly at right angles to the grain. Thrust termination is achieved by blowing a port opposite the aft nozzle end.



ARTIST'S DRAWING of proposed Nova launch complex to be built at Canaveral.

• **Space engine**—Sloop outlined an advanced liquid propulsion system NASA expects to investigate as an advancement in the state of the art. While very simple, the system—if it is successful—will possess all the required characteristics of a spacecraft propulsion mode.

The system will have long-term space storability, restart, variable thrust and reliability. Sloop described the system as having a gas forcing a liquid into the gas generator to produce pressurizing gas. This gas, after cooling in heat exchangers, is used to collapse the bladders containing fuel and oxidizer. This forces propellant through the thrust control valve into the combustion chamber. Propellants ignite on contact.

Sloop mentioned that certain critical items must be investigated before the system becomes a reality. These are radiation-cooled thrust chambers, throttling injectors, expulsion bladders, restartable gas generators, leak-proof valves and compatible materials.

Other items covered included the effects of space on both solid and liquid propellants. Sloop said radiation in space will affect the burning times and physical properties of solids. ⌗

Fifteen Firms to Submit Nova Study Plans

NASA HAS INVITED 15 missile/space firms to submit proposals for a detailed systems definition and preliminary design of the Nova superbooster.

Proposals are due April 26; contract award is due in May.

Two of the 15 firms will be chosen for a parallel coordinated approach to the problem, NASA said. The study contract will last about six months, and a contract for actual development of the big launch vehicle will be awarded before the end of the year.

NASA said it was willing to commit $700,000 to each of the firms in the study. In addition, each firm will include as part of its proposal a statement as to how much of its own funds it is willing to commit.

Nova is the largest rocket presently planned by NASA. It will be capable of placing more than 200 tons in Earth orbit, or sending more than 75 tons on an Earth-escape trajectory. Nova thus will be able to perform manned lunar landings with Apollo spacecraft in direct flights from the earth.

While the firms selected will perform only a design study, there is a possibility that they may later be awarded the production contracts for the large launch vehicle. This was implied in the space agency announcement, which noted that "requests for bids are being offered to firms having a capability of participating in follow-on hardware development."

Nova development will involve two contracts, one for the first stage and the other for the second stage.

The 15 firms include: Aerojet-General Corp.; Bell Aircraft Co.; Boeing Co.; Chrysler Corp.; Douglas Aircraft Co.; Ford Motor Co.; General Dynamics/Astronautics; Grumman Aircraft Engineering Co.; Ling-Temco-Vought, Inc.; Lockheed Aircraft Corp.; Martin Co.; McDonnell Aircraft Corp.; North American Aviation, Inc.; Northrop Corp.; and Republic Aviation Corp.

Nova's first flight is expected in the 1966-67 period.

The Nova first stage will develop about 12 million pounds thrust, using F-1 oxygen/kerosene engines. Minimum lift-off weight of the vehicle will be about 5000 tons.

The Nova second stage will use multiple M-1 engines—a 1.2-million-lb.-thrust liquid hydrogen/liquid oxygen engine for which Aerojet-General was recently chosen contractor. The third stage probably will be powered by a J-2 engine.

The two contractors will be selected to:

—Develop a detailed set of criteria and model specification for the complete Nova vehicle, supported by a detailed preliminary design.

—Define a manufacturing plan including the fabrication methods, inspection and test methods as well as major facility and equipment requirements.

—Determine the method of achieving acceptable reliability at the earliest feasible date.

—Define the testing program required.

—Describe the method of transportation and equipment.

—Develop a schedule, funding and management plan for the overall Nova program.

For House committee . . .

Holmes Describes Manned Lunar Mission

The following are excerpts from D. Brainard Holmes' narration of events during the first U.S. manned lunar landing mission, using the orbital rendezvous concept of space flight. It was presented before a hearing of the House Space Committee.

THE UNMANNED escape stage is launched first, while the Advanced *Saturn* that will transport the *Apollo* spacecraft is in the last stages of preparation and check-out.

When the escape stage is in orbit, on-board automatic equipment performs a complete check-out of the stage and relays the information to the command center on the ground. Only when this stage is known to be in full operating condition are the astronauts sent aloft.

The manned launch is made a day later and within an interval (about an hour) that will permit early interception of the escape stage already in orbit. As the *Apollo* spacecraft rises to orbit, it overtakes the escape stage which has been tracked by the *Apollo* and also from the ground.

The spacecraft moves in front of the escape stage and the docking maneuver is performed. This operation is performed by the astronauts, using precise tracking and positioning equipment.

When the two vehicles are properly joined, and when they reach the precise point in the orbit for departure to the moon, the escape stage fires and burns for about seven minutes, giving the *Apollo* the necessary speed to make the 2½-day journey to the vicinity of the moon. When the escape stage has performed its function, it is jettisoned and the *Apollo* spacecraft proceeds alone.

• **Busy hands**—During the 2½-day journey to the vicinity of the moon, the three astronauts are performing many important functions in a weightless condition. They keep close tabs on solar radiation levels, and are constantly alert to the threat of a solar flare. . . .

The astronauts navigate and control their spacecraft by taking bearings on the earth, moon and stars. They can turn the spacecraft in various directions to facilitate navigation and communication with the earth. Periodically, they check out every piece of operating equipment in the spacecraft and report back to earth. They are performing numerous scientific observations including those of a medical nature. They are reporting periodically on their physical and mental condition. . . .

• **Landing** — When the spacecraft arrives at an appropriate distance from the moon, the landing engines are turned on to produce a low-altitude orbit. The moon is now under continuous radar and optical observation, so that the astronauts can navigate to the pre-selected landing site.

When this point is reached, the spacecraft is turned with its landing engines toward the moon, and a carefully controlled descent begins, until the *Apollo* is hovering over the landing area. The next operation—that of the touchdown—is probably one of the most critical maneuvers. . . .

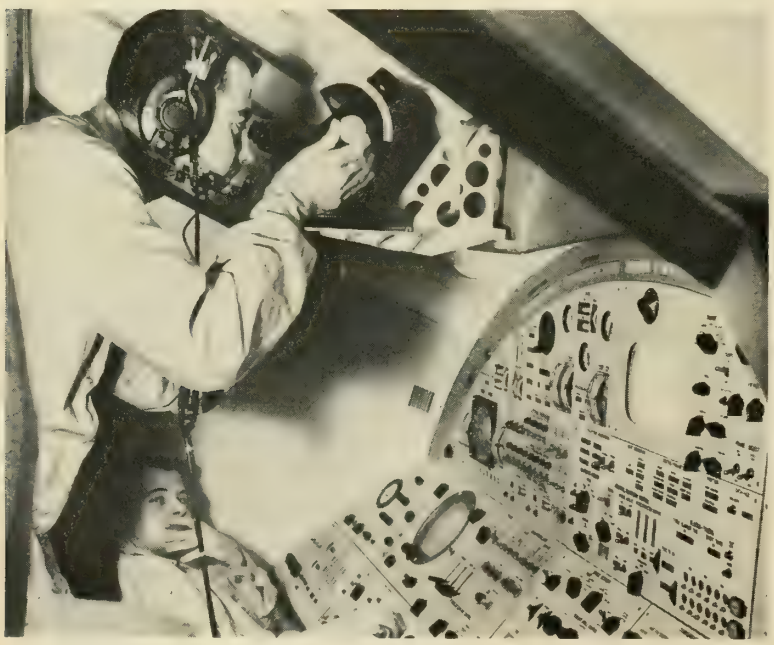
The astronauts spend at least one day upon the moon. . . .

• **Take-off** — Having completed their work, the astronauts return to the command capsule and fire the take-off rockets. This one firing imparts sufficient velocity to propel the capsule away from the moon and to return it to the vicinity of the earth. En route to the earth the astronauts perform many of the same tasks they did on the way out, including mid-course corrections. This time they must hit a 40-mile-wide re-entry window several hundred miles above the earth's surface; guidance requirements are extraordinary.

For the final approach, they are assisted by precise ground tracking. After the spacecraft has entered the corridor, the service module is jettisoned and the command module is ready to begin its descent to the earth.

The command module is now hurtling through the atmosphere and is subjected to the maximum temperatures and accelerations it encounters during mission.

• **Descent**—At about 10,000 feet, the large parachutes are deployed to bring the capsule safely to earth. Landing occurs in a pre-designated and prepared area where the capsule is tracked by many radars and optical instruments. When the capsule is down, recovery teams proceed immediately to the landing point to pick up the astronauts. ⌘



NASA Crewmen To Train in Martin Simulator

SEXTANT will be used to check course during "flights" in Martin Co. spacecraft simulator. Firm last week won contract from NASA to study confinement effects on crew.

Opposition falters . . .

Nike-Zeus Looks Finished as Weapon

Defense Secretary McNamara hints anti-ICBM program may be dropped in two years; still-confident Army attempts to refute criticisms; Kwajalein tests will not affect decision

by James Trainor

IT NOW SEEMS unlikely the Army's controversial *Nike-Zeus* anti-ICBM system will ever be put into production.

Department of Defense decisions apparently have doomed *Nike-Zeus* to a purely research and development program designed to gather data on warhead and decoy signatures and to produce information that may help development of a future antimissile missile system.

Secretary of Defense Robert S. McNamara has intimated strongly, in fact, that *Nike-Zeus* has only two more years of life.

"I believe it would be wise to continue it for an additional year beyond this year," the Defense Secretary told a Congressional committee recently, "and very probably to the completion of what we would call the development phase."

A surprising reaction to the Secretary's comments is the seeming acquiescence of both the Army and Congressional committees. In past years, there has been a strong contingent in both houses of Congress which has urged production and deployment of the *Zeus* system. This year, the once-formidable bloc seems to have been reduced to Rep. Daniel J. Flood (D-Pa.).

The Army itself has shied away from taking its case to Congress. The reason as explained by one Army official: "Nobody wants to get into a fight with that man upstairs."

The Army, in fact, is taking a new look at its role in a *Zeus* program which would be limited purely to research and development, with no hope of production.

"We can continue the program," says an Army spokesman, "but we are really not interested in a purely Ballistic Missile Research Program. This is more ARPA's concern. We want a weapons system."

• **Innocent remarks**—McNamara's pessimism about the effectiveness of *Zeus* first came to light publicly last month on a New York television show. He asserted that no amount of money

←
ARMY'S NIKE-ZEUS appears fated for termination within next two years.

can make possible an absolute defense of the United States against ICBM's.

Initially, Army officials refused to comment on the Secretary's statement. Later, they contended that his remarks "were really quite innocent" when taken in context. The Army, they said, agreed with the Secretary that there is no absolute defense against a ballistic missile attack. Therefore, they felt, the press had manufactured the possibility of a controversy.

The extent of McNamara's reservations about the *Nike-Zeus* was clarified last week by the release of his heavily censored testimony before the House Armed Services Committee, the Subcommittee on Department of Defense Appropriations and the Senate Armed Services Committee.

In his unclassified testimony, the Defense Secretary raised several "serious questions" about *Zeus*. The primary objection to the system, he said, was its inability to handle a saturation attack by Soviet ICBM's. A corollary to this problem was the question of its ability to discriminate between an incoming warhead and a surrounding cloud of decoys.

Further, the Secretary said, "these systems would still not necessarily solve the problem of nuclear fallout from surface explosion outside the defended area."

Finally, the cost of an operational *Zeus* system was listed as a point of contention.

"It has been variously estimated," the Defense Secretary told the committee, "that a *Zeus* program to defend some perhaps 27 cities, the larger centers of population in this country, might cost between $10 billion and $14 billion."

• **Army still Zeus-confident**—Although Army witnesses before Congress expressed confidence in the *Zeus* system and made passing reference to authority of pre-production engineering funds, it was not until Lt. Gen. Arthur G. Trudeau appeared before the committees that Congressmen heard the other side of the story.

Expressing "more confidence" in the system than ever before, the Army R&D chief compared the decision to develop *Zeus* to that of building fighter interceptors even "when we admitted 30% of the enemy bombers would get through."

"We are in a position where both the possible enemy and ourselves are equipped with a sword," Trudeau pointed out, "and the fellow who gets the shield first is going to have a very advantageous position no matter how vulnerable or invulnerable the shield is."

Noting that the FY '63 RDT&E budget for *Zeus* was 3% below FY '62 —$267.5 million against $274 million in '62—Trudeau revealed that the Army was working on several improvements in the system which would extend its capabilities.

The first—an *"Advanced Zeus"*—would be essentially what the Army terms a "sprint missile." This would be a high-acceleration, quick-reaction missile considerably faster than even the present *Zeus*.

Such a missile, the Army says, would enable the *Zeus* system to handle many more targets by taking one target at a time, firing a missile against it and then recycling to pick up and destroy the next target. This sequential, rather than simultaneous, handling of targets would, the Army feels, give the *Zeus* system the growth potential to handle the enemy threat.

The second improvement in the *Zeus* system is the addition of ZMAR—a multiple-array radar (M/R, Jan. 22, '62, p. 29).

Both of these improvements will be funded in the FY '63 budget. However, the $133.7 million requested for the pre-production program was, as in past years, deleted by DOD.

• **Kwajelin tests inconclusive**—Probably the hardest blow to the Army's hope for early production of the *Zeus* system is McNamara's belief that the system's effectiveness under combat conditions will not be proven by the Kwajalein tests.

"In actual combat," the Secretary said, "we could expect a greater number of missiles and missiles of varying types which the system might or might not be effective against."

Later, in a press conference, the Secretary said that the success or failure of the *Zeus* tests in the Pacific would have little bearing on his decision for or against production of the system.

That the tests against *Atlas*-launched target vehicles are not a test of an operational system against an operational system, the Army readily admits. However, Army officials point out that the tests must be controlled to a certain degree in order to maximize the data received from an individual test, as well as to keep within the safety and instrumentation limits of the test area.

Although these spokesmen say they would welcome a test of the *Zeus* under combat conditions, they point out that just as you don't test a tank under combat conditions to develop confidence that it can perform under fire—so the *Nike-Zeus* doesn't have to be tested to this extent.

Since the Kwajalein tests are designed to progress from relatively simple target vehicles to sophisticated, small radar cross-section nose cones with decoys and other penetration aids, Army officials feel the test series will prove the capability of the system.

• **Can war-game system to death**—Turning to the objections raised by Secretary of Defense McNamara, one Army spokesman pointed out that the system undoubtedly can be saturated if the enemy is willing to make the effort.

"Zeus is not a panacea," he admitted. "Its principal advantage is that it contributes significantly to deterrence by putting doubt into the mind of the enemy about the effectiveness of his attack."

Although more and more advanced threats are being postulated, he said, the Army feels that *Zeus* can handle the "realistic" threat—both present and future.

"Sure, it's easy to war-game this thing to death by adding just one more missile to saturate the system," another Army official said, "but the real question is 'how badly do you want a defense?' "

McNamara reservations about the system's discrimination capabilities puzzle Army officials. Although one discrimination system is operational at White Sands Missile Range, the second is just going operational at Kwajalein and, as yet, discrimination data is largely unavailable. Detailed information on the discrimination capabilities of the *Zeus* radar, Army officials point out, will only be available after the Kwajalein tests.

Nuclear fallout will certainly result from detonations outside *Zeus*-defended areas, the Army concedes in agreeing with the Defense Secretary that efforts should be made to minimize the damage from these weapons.

However, it is pointed out that the *Zeus* itself will not contribute to this fallout—except on a long-range, worldwide, atmospheric basis.

The Army admits that deployment costs would be large, but it feels that the precedent has been set for spending of this magnitude on air defense. Currently, they note, the country is spending over a billion dollars in this area annually.

Pointing out the relative cost of the system as compared to other weapons systems, General Trudeau told Congress that the cost of the *Zeus* system is one-third of what SAC cost in the decade 1950-60; one-third of the cost of continental air defense 1950-60; one-half of the cost of U. S. IRBM's and ICBM's through 1966; one-half of the cost of fighter aircraft in the period 1950-60.

• **When to decide?** — When Army officials are asked when a decision is required on production of the *Zeus*, their answer is the same. "Now, a couple of days ago, a couple of years ago."

The decision apparently has been made. ⌗

Over $85 million in FY '64 . . .

NASA's ComSat Funding To Climb

NASA SPENDING for communications satellites will continue to increase over the next two years.

Milton Stoller, director of the space agency's Office of Applications, told M/R that ComSat funding — which jumped to $85 million in Fiscal '63— will go up a little more in Fiscal '64.

Development of advanced satellites will boost the spending, he said.

Stoller also gave the first indication that NASA favors 22,300-mile-high satellites for incorporation into a commercial communications system.

"I would think," he said, "that when all the technology is in hand, it will be the synchronous-orbit satellites which will be the most attractive to us."

Previously, NASA officials testifying before Congress had repeatedly refused to take sides as to what type of satellite would best fit into an operational communications system.

• **No chasms seen** — The nation's largest communications company, American Telephone & Telegraph Co., favors the use of low-altitude satellites. This would require about 200 to give complete global coverage.

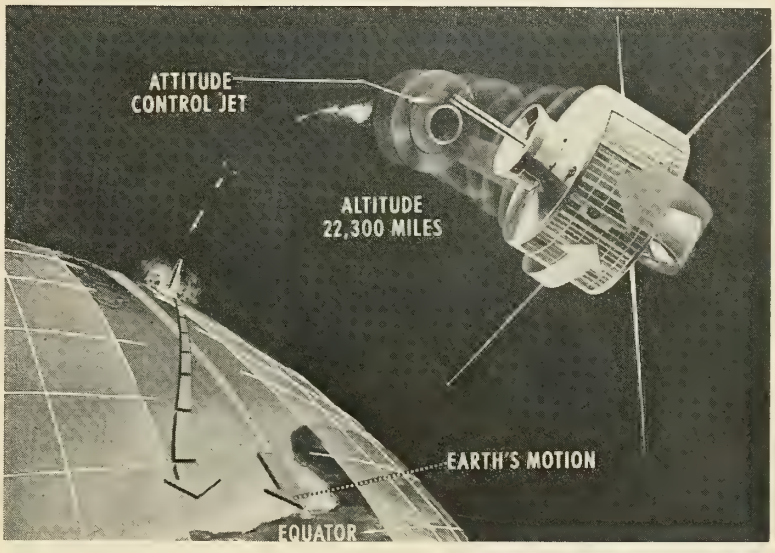
Missile/space firms—and now, apparently, NASA—have favored the use of the synchronous-orbit satellite system in which only three satellites could send and receive communications from any point on Earth.

Stoller, who directs NASA's communication and meteorological satellite programs, said that the synchronous-orbit system reduces the number of launches and ground antenna which would be required.

He admitted, however, that it does have drawbacks—including the difficulty of placing and keeping the satellite in a 22,300-mile orbit. Another major problem is the "loop delay" in which there is a fraction of a second's delay in messages sent to the satellite.

Stoller declared that the spacecraft problems in the synchronous system will be solved. "At this point, we see no yawning chasms," he said.

• **Hughes in early**—Hughes Aircraft Corp. has already submitted an unsolicited proposal to NASA for development of an advanced synchronous satellite. A contract for the advanced satellite—a follow-on to the *Syncom* series—will be awarded in Fiscal '63.



SYNCHRONOUS-ORBIT satellite system—now apparently favored by NASA as well as missile/space firms—would call for only three satellites to cover entire globe.

A contract for an advanced version of the low-altitude *Telstar* satellite series will also be awarded.

Stoller said that so far Hughes has been the only firm to submit a proposal for the advanced *Syncom* which will be launched with an *Atlas-Agena* in 1964. Other reliable sources reported that NASA has already accepted and approved the Hughes proposal.

Stoller also disclosed that:

—The use of nuclear power in communications satellites is still a couple of years away.

—NASA expects that another year's study and review will be needed before the potentialities and requirements of a national navigational satellite system are known. He said that the system—based on the Navy's *Transit* satellite—hold promise. Program recommendations, including an additional flight schedule if one is required, will not be made until the study is completed.

—A limited operational commercial communications satellite system could be achieved in the 1965-66 period. It would be limited, he said, in that it would not be equivalent to the telephone services we now have. Furthermore, he said, it will be feasible only if commercial interests (communication carriers) are ready to move ahead.

—NASA has had a pilot study going on in the Midwest to determine what portions of its research and technology efforts may be of practical interest and value to American industry. This is the chief job of Stoller's Office of Applications.

Among the products which NASA feels may be applicable to industry so far are leakproof connectors in hydraulic systems, sensor techniques in aeromedical work, and a pyrotechnic device which snips antennas.

A complete study of possible commercial R&D applications will be completed within the next year.

—Stoller said he and other communication and meteorological satellite experts at NASA would be available as advisors to Deputy Administrator Hugh L. Dryden, who has been selected by President Kennedy as chief U.S. negotiator of a space cooperation agreement with the USSR.

No formal plans have yet been made for the officials to join Dr. Dryden in New York, where the negotiations are being conducted.

One important fallout from Russian participation, he said, would be 24-hour daylight coverage of the Earth's surface. The present *Tiros* satellite series provides only 12-hour coverage. ⌘

Crowd of 70,000 . . .

IRE Told Market Will Double by '72

NEW YORK — A total electronics market in 1972 almost double the $11.7 billion of last year was predicted here last week at the international convention of the Institute of Radio Engineers.

The forecast came from Patrick E. Haggerty, IRE President and president of Texas Instruments, Inc., who also foresaw a big jump in the military and civilian space market—an increase of $3.1 billion by 1972 over last year's $6.9 billion figure.

Haggerty spoke in a pre-convention press conference, before the New York Coliseum was deluged by more than 70,000 engineers, businessmen and sightseers.

This year's industrial show, including exhibits from 856 electronics firms, filled to capacity the four complete floors and additional mezzanine space available. Many displays spilled over into areas generally used for technical sessions.

"This exceedingly large display" was appropriate, Haggerty declared, so that IRE could show off the accomplishments of its members, as in previous years. "This is the output," he said.

But many observers reflected that an even greater extravaganza may be expected if the proposed merger of IRE and the American Institute of Electrical Engineers is approved, as expected.

IRE claims 97,000 members; AIEE lists 70,000. Joining of the two into the projected Institute for Electrical and Electronic Engineers (IEEE) would draw an audience estimated at over 100,000 persons to an annual spring convention and show in New York.

So large an undertaking would, many at this meeting felt, be of questionable value considering the expense of participating, time away from company projects, and the possibility of being totally lost in an overwhelming display of hardware.

This year's IRE meeting included 54 technical sessions in 28 different fields represented by 265 papers. The recent AIEE show here included 118 technical sessions, more than 100 company displays.

• **Manpower fears** — Although the market picture looks rosy for the next decade, one IRE official expressed grave concern over the engineering and scientific manpower shortage.

IRE HEAD HAGGERTY
For missile/space—$10 billion by 1972.

Dr. Frederick E. Terman, of Stanford University, stressed that he feared the deficit in technical competence more than the statistics on the number of technical "bodies" turned out each year.

James M. Bridges, Electronics Director in DOD's Office of the Director of Defense Research and Engineering, also expressed worry over the outcome of the technological race with Russia. Over 80% of all U.S. electrical engineers are, he said, engaged at least indirectly in defense tasks.

At the present time, Bridges asserted, development costs are excessive, the time interval for RDT&E is too long, and our creative resources are spread too thin. At our present rate, he added, technical manpower demands will exceed supply in 5 to 10 years, if government and industry don't take preventive action.

• **Direct space TV impractical?**— At one technical session, an extremely pessimistic view of proposals for direct TV broadcast via orbital relay stations was voiced by Dr. Richard C. Gould, of Stanford Research Institute.

Gould reported on a broad study based on those schemes suggesting use of a stationary (synchronous) equatorial orbit.

It has been assumed throughout most existing proposals that a 24-hour satellite would obviate the need for tracking antennas or special equipment at the receiving end, Gould said.

He then noted the problems immediately encountered throughout North and South America with respect to time zones, language barriers, and the use of different transmission standards (the U.S. standard of 525-line raster vs. the Western European 625-line raster).

If direct transmissions to Europe and Africa are also considered, these same problems become even more acute, he asserted.

Considerable doubt was cast by the scientist on possible programing advantages of a hemispheric system.

He conceded that it would permit instantaneous transmissions over a wide range without the need for extensive ground lines or microwave support between stations. However, he maintained that although the existing transcontinental microwave network makes possible simultaneous broadcasting within this country, little use is made of it. Of the total hours (147) in 1961 devoted to such broadcasts, all but 16 hours were for professional baseball games. The remainder was for newsworthy events and news commentary.

The justification for proposing a satellite-TV direct broadcast system has been its usefulness in transmitting significant world events. Gould expressed concern that the total time required for events of this nature would be even less than the 16 hours required in the United States during an entire year.

Next, by a series of computations, Dr. Gould showed the extremely high-power requirements that continental coverage would require of a relay satellite. For example, he estimated that for U.S. and Canada coverage on Channel 13, 44 kw would be needed; for Channel 83, 145 kw would be required.

Finally, Dr. Gould pointed out that even for regional coverage it still is not certain that a one-channel satellite system would prove to be less costly than an adequate ground network for any country not now provided with such a ground system.

The Stanford scientist emphasized, however, that these problems would not be encountered with a relay/rebroadcast system using the satellite for global relay and delayed rebroadcast from existing ground facilities. ⁂

Technical Countdown

ELECTRONICS

ight Microwave Modulated

A beam of light has been successfully modulated at icrowave frequencies by researchers at Aircraft Armaents, Inc. The modulator uses the Pockels effect in crystalne material—somewhat analogous to the Kerr effect in iquids. It consists of an electro-optic crystal placed within he electrical field of a microwave cavity. A non-radiating ole on two sides of this cavity permits the beam of light o pass through. A 20-watt pulsed microwave source (700 o 1200 mc) achieved an estimated depth of modulation of 0 to 20%. Modulation of Laser energy at microwave requencies is planned.

Cryogenic Associative Memory Developed

A cryogenic associative memory circuit which simultaneously compares all stored computer information, rapidly associating input data with any portion of related information contained in its memory, has been developed by GE's Heavy Military Electronics Dept. This first operative unit of its kind, says GE, will provide a greatly simplified design approach to high-speed, large-storage computer memories. The device was fabricated through standard thin-film techniques using evaporative methods and circuit-pattern stencils.

High-Speed Computing Techniques Developed

Data rates in excess of 1 gigacycle are possible through a computing technique perfected by scientists at ITT Federal Labs. The logic elements of the computer are simple microwave mixers and filters with six interchangeable inputs which accept either data or the control signals that set up the element for the particular operation to be performed. Performing as a "nor" gate in one clock interval, the element may be used as a 3-bit "and" in the next.

Continuous-Wave Gas-Phase Laser Marketed

Helium-neon gas-phase lasers producing a continuous beam of coherent light of about 1 milliwatt at an output wavelength of 11,530 angstroms are commercially available from Perkin-Elmer's Optical Maser Dept. Developed by both P-E and Spectra-Physics, Inc., the device weighs only 13 lbs. and can be mounted on standard optical benches. The beam produced is highly directional, with a spread of less than 1 minute of arc when focused to a parallel beam.

RACEP Test Sets Delivered

Test sets of Martin Co.'s RACEP (Random Access and Correlation for Extended Performance) communications system have been delivered to AF/ESD and the Army's Signal Corps Electronic Proving Ground ahead of schedule. Six sets were ordered by the Air Force and four by the Army. The system fragments and codes speech signals into minute sections combining at random, and transmits them all at once over the same channel. Pre-set receivers reconstruct specific conversations into normal speech.

Power Rectifiers Upgraded

Hughes Aircraft Co. has designed silicon power rectifiers capable of operating frequencies up to 150 kc with efficiences in excess of 90%. The firm calls the development a breakthrough, since previously available power rectifiers begin to lose their efficiency above 10 kc.

Du Pont's Thinnest Film Yet

A 15-gauge (0.00015-in.-thick) Mylar polyester dielectric film with a nominal yield of 133,000 in.^{2}/lb. was introduced by Du Pont at the IRE meeting last week. Electrical characterization studies of the film show the same high levels associated with thicker Mylar films. The dielectric makes possible structures with substantially increased capacitance per unit volume in low-voltage circuitry.

ADVANCED MATERIALS

World Lead Claimed in Fine Wires

A London firm, Glass Developments Ltd., is producing glass-insulated wires down to a thickness of only 3 microns, and claims a world lead in the field. The company is making the wire in 0.5-kilometer lengths, but can produce longer units if desired. The production method involves RF heat to melt a wire within a glass tube. Radiated heat from the wire melts the glass, and a fine thread is drawn from the molten blob, forming a glass-coated metallic filament. The high surface tension of the glass insures a truly circular wire with a smooth surface finish. The process also can produce extremely fine bare wires by etching the glass away. The insulation can stand temperatures up to 200°C and voltages to 5 kv d-c.

Apollo Re-Entry Shock Tube Perfected

Shock speeds greater than 25,000 mph with temperatures reaching 90,000°F are being achieved in an electrically driven shock tube at Avco/Everett. The high temperature is in the newly-discovered non-equilibrium radiation range—air temperatures suddenly shoot up to over 90,000°F under very high shock speeds and, for a short time, radiate a huge amount of heat to the re-entry vehicle. The tube can simulate re-entry speeds of more than 36,000 fps. A new heat transfer gauge is used to measure the amount of heat being radiated from the shock wave. This measurement must be made in less than two millionths of a second.

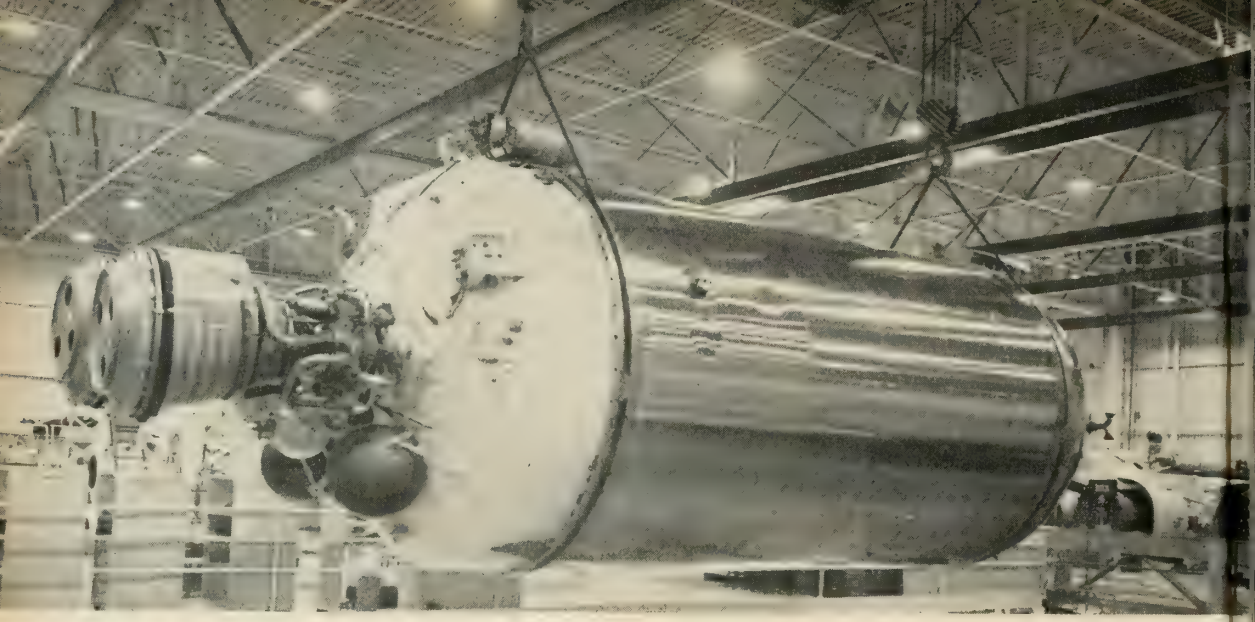
Lighter Batteries Through Separators

A tissue-thin modified polyethylene membrane has prolonged service life of silver batteries by a factor of 100 when used as separators. The *Permion* membranes, developed by Radiation Applications Inc., are ion-selective. With a stable pore size of molecular dimensions, the separator remains fine enough to inhibit the migration of silver plate ions while permitting the free passage of electrolyte. The development, the firm says, should lead to a greater use of silver batteries in space applications by taking advantage of their power/weight factor.

PROPULSION

Pershing Motor Checkout Simplified

Redstone Arsenal engineers use a simple profilometer to search for cracks and bulges in the interior of solid rocket motors. Mounted on a 14-ft. aluminum rod, a small wheel on a flexible arm and connected to a strain gage is run back and forth over the propellant. The large-scale measuring rod saves time—it surveys one *Pershing* motor in an hour. The measurements are accurate to 0.0005 in



space electronics

Unique Centaur Guidance Ready to Fly

Inertial system developed by Minneapolis-Honeywell for complex maneuvering

by Charles D. LaFond

THE FIRST *Centaur* inertial guidance systems, designed expressly for space-mission use, are ready for initial flight-testing at Cape Canaveral. The space booster and its sophisticated guidance system are expected to be integrated and flight-tested over the next two years.

Developed for *Centaur* by Minneapolis-Honeywell, under contracts to General Dynamics/Astronautics, this also is the first guidance system capable of directing complex multiple stop-and-go space maneuvers.

GD/Astronautics in San Diego is prime contractor for the *Centaur;* Marshall Space Flight Center in Huntsville, Ala., directs the development program for the National Aeronautics and Space Administration.

Coupled with a first-stage modified-*Atlas* booster, the spacecraft is the first high-energy U.S. vehicle capable of placing a 4.5-ton payload in low orbit (300 mi.) or of sending large instrumented probes (up to 1450 lbs.) into outer space. Second stage of the *Atlas-Centaur* is the first U.S. rocket to employ liquid hydrogen as a fuel with liquid oxygen.

• **Test plans**—Initial flight test of the *Atlas-Centaur*, last scheduled for March 29, is now set for April 6. Principal goal in this launch will be to check out engine operation and booster structure performance in each stage.

Because a simple ballistic trajectory is planned, the guidance system will be installed to ride primarily as a passenger. Although not connected to control the vehicle, it will be set to operate as if it were.

Details of its operation will be telemetered to ground stations to permit later analysis of its performance under flight conditions.

Flight stabilization will be achieved by means of a programed autopilot. Radio command from the ground will not be employed. However, a sun-pointing function of the M-H guidance system is scheduled for use during the second-stage, unpowered phase of the test flight.

During operational use, the solar orientation will be applied to keep the aft end of the *Centaur* pointed directly at the sun. This will minimize the area subjected to solar heating and help reduce liquid hydrogen boil-off.

A total of seven *Atlas-Centaur* flight tests are planned, three in 1962 and four in 1963. NASA officials say the space system will be considered operational with the eighth launch in 1964.

• **Guidance production** — GD/A awarded Honeywell the first *Centaur* inertial guidance system contract in July, 1959. This $5.4-million award called for development and ultimate construction of nine systems, including ground checkout equipment.

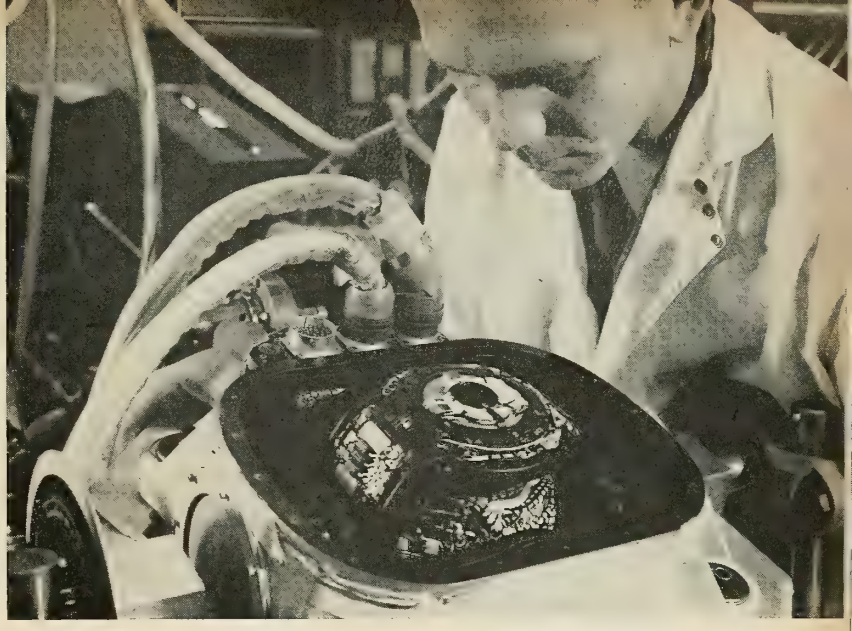
Honeywell selected the Librascope Division of General Precision, Inc., in Glendale, Calif., to develop and produce the guidance computer and associated input/output equipment.

A second contract was received by Honeywell in June, 1961, for the production of eight more complete systems.

This current contract, which runs through the end of 1962, is expected to total $5 million.

(To make use of what amounted to an off-the-shelf guidance package, Honeywell, as associate prime contractor for primary guidance on the Air Force *Dyna-Soar* program, will employ the *Centaur* stable platform and associated electronics in the boost glider.)

• **Hardware details**—The guidance system was developed by Honeywell's Aeronautical Division of Minneapolis and was built at its facility in St. Petersburg, Fla.



LEFT: *First Centaur test vehicle was hoisted from its dock at General Dynamics/ Astronautics San Diego plant in spring of 1961 and moved to nearby Sycamore Canyon for static testing of engines and systems. Centaur is first high-energy U.S. space vehicle, and first to be powered by liquid hydrogen. A modified Series D Atlas will be used as launch booster. Centaur is powered by two Pratt & Whitney hydrogen-oxygen rocket engines of 15,000 lbs. thrust each. Overall, the Atlas-Centaur vehicle is 10 ft. in diameter and 107 ft., 8 in. long.*

RIGHT: *Inertial guidance platform (cover removed) for the NASA Centaur vehicle undergoes final testing at Minneapolis-Honeywell's inertial guidance facility in St. Petersburg, Fla. The 25-lb. platform employs a four-gimbal structure providing freedom of movement in any direction.*

Overall, the complete guidance package weighs about 130 lbs. This includes the stable platform, computer, all associated electronics, and the power supply.

Solid-state circuits and printed circuits are used throughout the system and exteriors are gold-plated to assist in internal temperature control.

The gyros and their associated gimbal-drive servo loops serve to keep the first (azimuth) gimbal in a fixed relationship to inertial space—the prime reference for the guidance system.

To guide the *Centaur* onto the correct trajectory, the system senses acceleration changes in each axis, determines platform and vehicle attitude, generates steering commands for correction to the flight control system, and finally commands engine cutoff when programed velocity, attitude, and time conditions have been attained.

Subsequent engine restart and stop operations to achieve a transfer ellipse and to change the trajectory plane and velocity are under programed velocity control. For each stage of powered flight, a required velocity vector is defined for each point in space and time enveloping the nominal trajectory.

—*Platform*—The four-gimbal inertial platform contains three miniature integrating gyros and three pendulous accelerometers. The complete platform is comprised of an outer case, gimbal structure, gimbal drive motors, and gimbal angle resolvers, plus the inertial components. The whole assembly weighs 25 lbs. and occupies about 0.5 cu. ft.

—*Platform electronics*—The associated platform electronics unit carries the four gimbal-control amplifier assemblies, three resolver isolation amplifiers, function switching facilities, associated networks and a blower for thermal stabilization.

The units are packaged in a lightweight tubular container with domed end-caps. The compact construction assures that the package will withstand the required pressurization. Weight is about 17 lbs.; the container measures 15 in. x 7½ in. in diameter.

—*Pulse rebalance, gyro torquer, power supply*—A pulse rebalance loop is provided for pulse torquing the accelerometers to keep them positioned at null, and to furnish the computer with pulse information indicating velocity change.

Also, for gyro torquing, the control field of each gyro is excited from the arm of a potentiometer in the computer, positioned by a digital servo.

The power supply includes a precision potentiometer regulator, −35-volt supply, +20-volt supply and regulator, precision frequency supply, synchronizing pulse supply, precision current supply and gyro-pattern field-current supply.

In all, these units weigh about 31 lbs. and occupy approx. 1.04 cu. ft.

—*Computer* — The 57-lb. digital computer performs both pre-flight and in-flight computations.

During the pre-flight phase, the necessary computations are performed for determination of both g-sensitive and g-insensitive gyro-drift trim coefficients, determination of accelerometer bias and scale factor calibration coefficients, fine alignment of platform to the initial position required for the in-flight phase and the repeated solution of a computer check problem.

During the in-flight phase, it handles the computations required for continuous three-coordinate steering, generation of signals to the programer which activate verniers and turn off main stage and vernier engines, generation of gyro-drift trim-torquing signals, prediction of initial conditions for later powered phases, reset of the computer control unit with restart time, and data processing for telemeter output.

A drum memory is provided for data storage in the computer.

—*Signal conditioner*—A signal conditioner package prepares selected guidance system signals for required telemetry transmission. It receives 19 signals and converts them to voltages that can be handled by the telemetry equipment.

• **Mission requirements**—The *Centaur* is designed for as many as three restarts during any given flight. The guidance system was developed to perform the standard attitude and velocity control functions, as well as to direct the complex engine stop and restart operations necessary for spatial maneuvers.

Thus, the space vehicle will be able to travel from launch phase into a preliminary orbit, park for a specific time period, fire again to kick into another planned orbit, and then repeat the whole process if required.

Such a technique might be used to achieve an equatorial synchronous (or 24-hour stationary) orbit. This is not possible now for heavy payloads launched from existing U.S. sites into single-orbit flights.

A primary application for *Centaur* will be placing the Army's *Advent* active communication satellites in synchronous earth orbits.

The system is flexible enough to place large payloads in precise orbits anywhere in the range of from 300 to 22,000 miles altitude.

Later, *Centaur* will be used to place a payload on the moon. ❖

So far we've only scratched the surface at Northrop Ventura

Construction is getting under way on the new home of Northrop's Ventura Division (formerly Radioplane). Located in Ventura County 50 miles northwest of Los Angeles, it will be ready for occupancy in December, 1962.

We've only begun to explore the capabilities of Northrop Ventura, too. *But what a beginning it is!*

Item: Northrop Ventura is making recovery systems for every manned space capsule now scheduled by the U.S., including the landing systems which have brought the Mercury astronauts safely back to earth.

Item: Northrop Ventura is now providing crew escape systems for America's high performance manned aircraft.

Item: Northrop Ventura target drones and missiles, surveillance drones and support systems are now in use by all three U.S. armed services and 14 foreign countries.

The new name and new facilities reflect Northrop Ventura's increasing capability in fields where its leadership is already well known... paradynamics, atmospheric re-entry and planetary landing systems, and surveillance systems. In addition the division will broaden its capability in nucleonics, invulnerability of weapons to nuclear effects, penetration aids for ballistic missiles, and other advanced fields.

NORTHROP

Pluto—the Gateway to the Stars

Most distant of our planets appears to have great density, will be in good position from 1969-2009

by Robert L. Forward

STEPS BEYOND MARS—*THIS IS THE FOURTH in a series of articles exploring the prospects for probes and manned travel to the other planets of our solar system. Earlier articles discussed Jupiter (M/R, Dec. 4, 1961), Saturn (M/R, Jan. 8) and Neptune and Uranus (M/R, Jan. 22).*

Author Robert L. Foward is a Hughes Research Laboratories physicist who has published many papers.

AS THE twentieth century closes, man will be completing his first steps into the outer reaches of the solar system. He will now settle down to a period of consolidation and an investigation of just what he has obtained for his efforts.

He may find that there are things of practical value out there. But it is more likely that the result of this efforts will be more intangible. Mostly he will have learned a great deal about the capabilities of the human mind and body.

After the solar system has been explored man will have to wait. Star travel is not a trivial problem. We are stopped cold by the slow crawl of the speed of light and the almost instantaneous winking on and off of the average human lifetime. If we are lucky, a genius may come along and show us a way around the limitation of the speed of light. But it is more likely that we will solve the problem in the same way that we are pushing into the thermal thicket of atmospheric flight—we will engineer our way into it.

• **The planet**—Pluto is the outermost member of the solar system and very difficult to observe. The astronomers have been able to drag a few facts out of Pluto. But the frustrating part is that by using these hard-won facts they can easily prove that such a planet can not exist

It all started back in the 1820's when it was found that Uranus was not following a smooth elliptical orbit. It was finally realized that the erratic behavior was due to another planet still further out. Two mathematicians tackled the problem and independently calculated the orbit, position, and mass of the hypothetical planet.

With the position in the sky known, it was a simple matter for the astronomers to find the new planet, Neptune, which till then had been overlooked. As soon as Neptune was discovered, the orbit of Uranus was recalculated and this time the observations fitted perfectly—almost. There were still small differences between the predicted and the actual positions.

Spurred on by the success of the previous work, Professor Percival Lowell thought that there might be another planet still further out. He calculated that it should be four thousand million miles out from the sun, moving in an unusually elliptic orbit with a period of 280 years and a mass of six times that of the earth. The same figures were later obtained by another prominent astronomer, Professor W. H. Pickering.

An object six times more massive than earth should be easy to find; so in 1905, Professor Lowell sat down at his moderate-sized but adequate telescope and started looking. He died without finding it. It was there, but it was much fainter than it had a right to be and he had missed. it. Later searches with photographic plates missed it although it was photographed twice. Once it was masked by a bright star, and the other time the image fell on a flaw in the negative!

• **High density** — It wasn't until 1930 that Pluto was found. The radius, eccentricity and period of the orbit were almost exactly as Lowell has predicted. Because the orbital calculations were so closely verified, there was no reason to doubt Lowell's prediction that Pluto had a mass of six times the earth's mass, except that the size of the planet was impossibly small. It was so small that it still looked like a point through the telescope.

It wasn't until 1950, using the 200-in. Palomar telescope, that Pluto's diameter was measured. It was roughly 3600 miles, or about as big as Mercury. This would make the density of the planet hundreds of times greater than water. The earth is only 5.5 denser than water and Osmium, the densest known material, is only 22 times denser.

Thus Pluto seems to be made of collapsed matter, except such matter should only be stable in the interior of dwarf stars. Such a planet should not exist! But it does!

The astronomers have tried everything in an attempt to make sense out of what they know, including "fudging" the numbers a little. There have been suggestions that Pluto is a very smooth sphere covered by large methane

THEORETICAL METHOD for providing power for interstellar travel is use of a very large Laser in orbit close to sun. Laser would convert random solar energy into intense, very narrow light beams that would apply radiation pressure to solar sail carrying space cabin at distances of light years. Rearward beam from Laser would equalize light pressure. Author Forward observes, however, that the Laser would have to be over 10 kilometers in diameter. Therefore other methods must be developed.

oceans, and the small observed diameter may be due to specular reflection. (There was a similar effect present with the *Echo* balloon.) But there are slow variations in the intensity indicating that Pluto is rotating with a day of 154 hours, and one would expect rather sudden changes in intensity from the specular reflections.

• **Pluto's Orbit**—The other unusual thing about Pluto is its orbit. The orbit is so egg-shaped that it actually passes inside the orbit of Neptune, so that they would at various times in the past and future pass every close to each other. Because of the high eccentricity of Pluto's orbit, during the years from 1969 to 2009 Neptune, not Pluto, will be the outermost member of the solar system. Thus, almost at the very time when we will have the capability of making the journey, Pluto will be in the most favorable position for exploration.

The astronomers feel that due to perturbations from the other planets, it is improbable that Pluto has been in its present orbit for more than 200 million years. This is only a small fraction of the age of the solar system; apparently Pluto is a stranger which arrived in its present orbit from other regions of space. One suggestion is that it was once a moon of Neptune.

• **Bode's Law**—There is one other nagging feature and that is the breakdown of Bode's Law for Neptune and Pluto. Bode's Law is an empirical formula for the orbits of the planets and the reason for its acceptance is best shown by the accompanying table.

There is obviously something wrong out past Uranus. It is as if Pluto had

PLUTO

Orbital Radius (km)	*4—8 x 10^9*
Period (days)	*90,700*
Rotation (days)	*6.39*
Radius (km)	*2,900*
Mass (kg)	*5—30 x 10^{24} ?*
Density (gm/cm^3)	*50—300 ? ! ?*

come along, interacted with Neptune and pushed it into an inner orbit, usurping its proper place in Bode's Law.

What we actually know about Pluto is very little. But this little bit that we know points out that it is imperative that we learn more about it. In the coming decades as the *Orbiting Astronomical Observatory* is put into operation and man ventures to the outer planets, we will get to know it better. If Pluto does turn out to have a super-high density, many important gravitational experiments will be called for, and a manned expedition to Pluto would be a certainty.

• **To the stars**—After visiting and studying the solar system, man is going to have to stop thinking in terms of km/sec, Astronomical Units, number of days flight time, minimum energy obital transfers and other provincial concepts if he wants to go out to the stars. Every one of his concepts will have to be increased by orders of magnitude.

Pluto is 5 light hours away, the stars are 5 light years away. To get to Pluto in any reasonable length of time, we will need characteristic velocities of 300 km/sec. To get to the stars in any reasonable time, the interstellar probes, manned or otherwise, will have to travel at appreciable fractions of the speed of light instead of an insignificant tenth percent.

• **Anti-matter rocket** — To obtain velocities near light using rockets, we need to complete conversion of matter. The most efficient nuclear reaction, the hydrogen fusion process, results in only a small fraction of the initial mass being converted into energy. An obvious method for obtaining complete conversion, which has been proposed by many people, is to use an anti-matter rocket.

A proton (hydrogen nucleus) and an anti-proton annihilate each other, as do electrons and positrons. Their mass is completely converted into energy in the form of high-energy gamma rays.

This sounds like a solution to the problem—and it would be a solution if you were a science fiction writer. But if you are a space engineer, there are a few little engineering details.

First, you must produce anti-matter. To do this you must build an ultra-high-energy-particle accelerator capable of many amperes of beam current. (The best site for such a machine is out in space.) This is so you can create grams of anti-protons per second (1 gram= 10^{23} atoms) rather than the few dozens of anti-atoms produced by present machines.

Second, you must store the anti-matter. Since anti-matter cannot touch normal matter without exploding, you have to make the container out of force fields. Since the anti-protons have a magnetic moment, it might be possible

PLANET	MERCURY	VENUS	EARTH	MARS	ASTEROIDS	JUPITER	SATURN	URANUS	NEPTUNE	PLUTO
Radius using Bode's Law	0+.4 .4	.3+.4 .7	.6+.4 1.0	1.2+.4 1.6	2.4+.4 2.8	4.8+.4 5.2	9.6+.4 10.0	19.2+.4 19.6	. . . . . .	38.4+.4 38.8
Actual Orbital Radius in Astronomical Units	.387	.723	1.0	1.524	2.8	5.20	9.54	19.2	30.0	39.5

to hold them in a magnetic bottle, but it will probably be easier to use electric fields.

One possible container would be a box made of six electron beam sheets. The anti-protons, having been made in our accelerator, would be decelerated and injected into the box. Since the anti-protons have negative charge they will be repelled by the negative electrons in the sheet beams and collect in the center. A beam of anti-electrons (positrons) taken from any convenient radioactive material and also injected into the container will be captured by the anti-protons to form anti-hydrogen.

If there is proper thermal radiation shielding, we will end up with a ball of liquid anti-hydrogen, charged negative, contained in a box of electron beams. When any of the neutral anti-hydrogen atoms evaporate off, as they go near the electron beams, the positron will be destroyed by an electron from the beam, and the anti-proton (with a negative charge) will be repelled back to the anti-hydrogen ball. Similar beams could conceivably be used to manipulate the anti-hydrogen so it can be squirted to the rocket chamber where a stream of normal hydrogen can react with it.

So far, we have been talking about things which have a physically plausible solution, although they may not be technically feasible. We now come to the last of the minor engineering details that stand in the way of our anti-matter rocket.

When the hydrogen-anti-hydrogen streams collide, the matter in the atoms will be transformed into pure energy, but the energy will be in the form of intense gamma radiation. We can stop the gamma rays in heavy lead shields and get our thrust this way, but the energy in the gamma rays will turn into heat energy in the shields and it will not be long before the whole rocket melts. What is needed is a gamma ray reflector—and such a material does not exist. In fact, there are strong physical arguments against ever finding any such material since the wavelengths of the gamma rays are smaller than the atomic structure of matter.

• **Star travel without rockets**—After a short investigation into relativistic rocketry, one realizes almost immediately that standard reaction methods are not the way to obtain speeds near that of light. If an interstellar vehicle has to carry the energy sources, the propellant plant and the reaction mass, then even complete conversion of mass to energy will not lessen the requirement for large mass ratios if we wish to approach 3×10^{10} cm/sec. Also, if even a small percentage of the energy goes into heat instead of thrust, then the temperature problems become great.

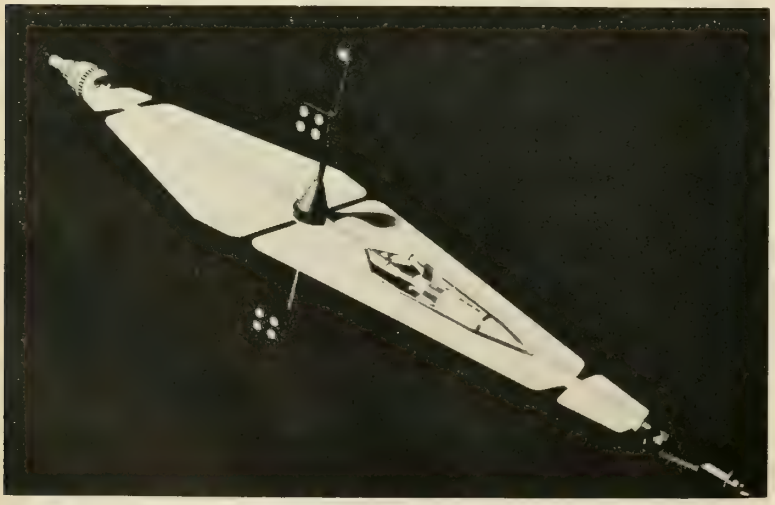
But we have made atoms go at the speed of light. How do we achieve these relativistic atomic particles? We do it by using a huge cyclotron, with tremendous energy sources, all to push one little atom. Thus we see that to achieve relativistic velocities with interstellar vehicles, the energy source and reaction mass must be external to the vehicle. This sounds like an impossible requirement, but one design which fits this concept is the solar sail. The energy source is the sun, and the reaction mass is in the reflected photons.

• **Lasers**—There is a way to extend the idea of solar driven sails to the problem of interstellar travel at large distances from the sun. This is to use very large Lasers in orbits close to the sun. They would convert the random solar energy into intense, coherent, very narrow light beams that can apply radiation pressure at distances of light years.

However, since the Laser would have to be over 10 kilometers in diameter, this particular method does not look feasible for interstellar travel and other methods of supplying propulsive energy from fixed power plants must be found.

• **Energy requirements**—No matter what method we eventually find to attain these speeds, the significant factor is that we have to give the interstellar vehicle an incredibly large amount of kinetic energy. Not ergs of energy, not joules of energy, not even megawatt-hours of energy, but *TONS* of energy. If an interstellar vehicle is traveling at half the speed of light then the mass of its kinetic energy ($M = \frac{E}{C^2}$) is 16% of the rest mass, or many thousands of kilograms of kinetic energy. This much dynamic energy should inspire awe in any engineer when he realizes that the total available electrical power output of the whole world for a whole year amounts to a few paltry kilograms.

Thus, interstellar travel will have to wait until man can generate and control the power of stars. But the future is not without hope. The present intensive research on a controlled fusion reaction is our first step to the stars. ❖



Fifteen-Man Mars Mission

AN INFORMAL CONCEPT of five nuclear/electric-powered vehicles in a task force exploration of the planet Mars was advanced by NASA's Ernst Stuhlinger and J. C. King at the recent American Rocket Society meeting on Electrical Propulsion. With three men in each vehicle, and emergency quarters for all 15 on any one craft, the 1½-year expedition would provide 29 days on Mars.

Air Force Backs Tennessee Center

TULLAHOMA, TENN. — A Graduate Center for Space Technology—sponsored by the University of Tennessee, ARO, Inc. and the Air Force—has moved a step closer to reality with the "enthusiastic endorsement" of the university's Board of Trustees.

To be built on Air Force-donated land near its Arnold Engineering Development Center, the graduate school is expected to offer a wide range of Space-Age subjects—not presently available in most U.S. educational institutions.

This curriculum is expected to lead to Masters' and Doctors' degrees in the space sciences. The center itself is envisioned as "a natural channel through which military requirements can flow into the Institute's research laboratories and into the development and production plants of the area's industry."

• **Proposal wins praise**—The idea for a educational institution at the Arnold Center was contained in Dr. Theodore von Karman's original study which led to the establishment of AEDC, but the proposal had lain dormant until last year.

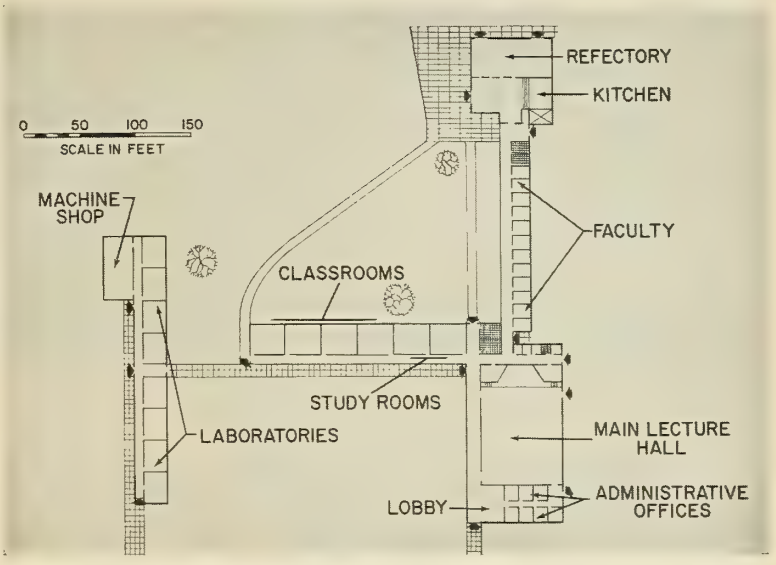
In November, Dr. B. H. Goethert, Director of Engineering for ARO, operating contractor of Arnold, proposed a university-sponsored space institute. This won the backing of both Maj. Gen. William L. Rogers, Commander of the Arnold Center, and Gen. Bernard A. Schriever, Commander of the Air Force Systems Command.

Governor Bufford Ellington of Tennessee and President Andrew D. Holt of the University of Tennessee also strongly endorsed the plan.

Recently, the Board of Trustees authorized the university to "proceed vigorously" with planning graduate and research programs in space technology, soliciting funds for construction and operation of the school, and obtaining immediately funds for architectural drawings to be used as the basis for detailed construction plans and fund-raising.

Although some delay is expected in getting the project under way, it is hoped that classes in the graduate center will begin in the fall of 1963. The delay results from the fact that the Tennessee State Legislature, which must appropriate funds for the project, does not convene again until February, 1963.

In the interim, five committees—composed of officials from the Arnold Center and the University—have been named to deal with specific problems, including curriculum, organization, faculty, laboratories and finances.



PROPOSED GROUND PLAN for $2-million Graduate Center, to be built in 1963 on land donated by Air Force near Arnold Engineering Development Center.

Initial cost of the center is expected to be about $2 million, with annual operating costs running to $500,000-$600,000. Since the Air Force has agreed to transfer more than 400 acres of land along the shores of Woods Reservoir to the University, the initial outlay will be devoted entirely to constructing and equipping the facility.

The Tennessee legislature is expected to appropriate some funds. However, additional support will be solicited from the Federal Government, foundations and industry.

• **Faculty & curriculum** — While definite plans have not been completed, officials estimate that the initial faculty will consist of approximately 12 full-time professors, 50 graduate students and 10 post-graduate workers and research assistants.

Part-time or periodical full-time employment of the Center's faculty members by the Arnold Center will be mutually beneficial, AEDC officials believe, because it will keep the faculty abreast of advances in technology while at the same time allowing them to aid in solving the Center's engineering problems.

Although they in no sense constitute a final program, these subjects have been suggested for the institute:

—Astrodynamics.

—Electronics of Space Technology.

—Chemical Propulsion by Liquid and Solid Rockets.

—Nuclear & Electrical Propulsion.

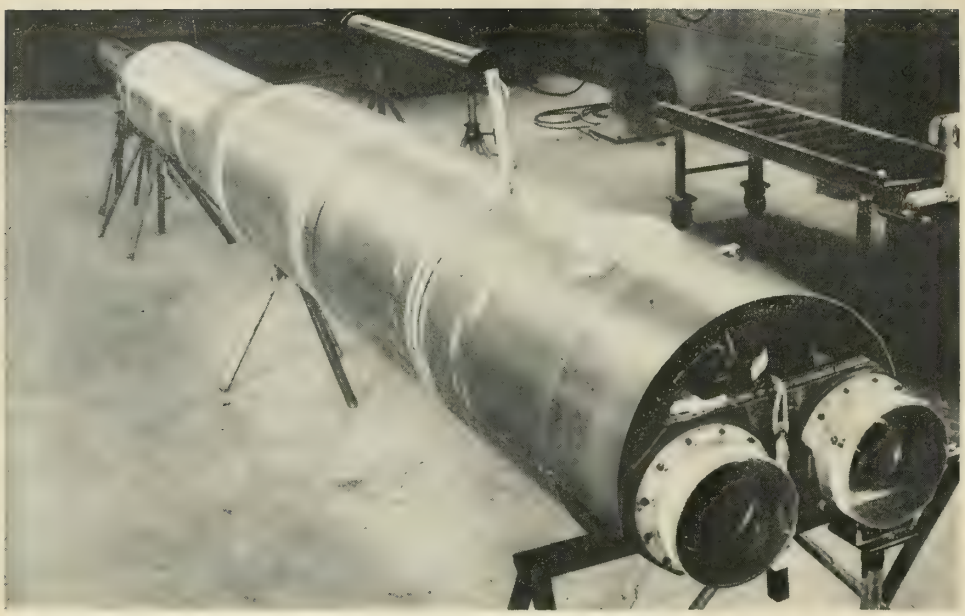
—Physics of the Upper Atmosphere.

—Structures and Materials under Space and Re-entry Temperature and Pressure conditions.

—Human Factors and Radiation Hazards.

In addition to the land, the Air Force has agreed to allow the graduate center to use many of its smaller prototype test units at AEDC, and to furnish support services from its technical library.

One of the major goals of the University of Tennessee-ARO-Air Force plan for the graduate center, according to Dr. Goethert, is "to form together with the new Research Institute in Huntsville, Ala., the twin focus points of aerospace research and industry of the South and, possibly also, of the entire nation." ⌗



LEFT: *Aerojet used this 16-ft. scale model of Titan II to establish design criteria in construction of operational underground launch silos.*

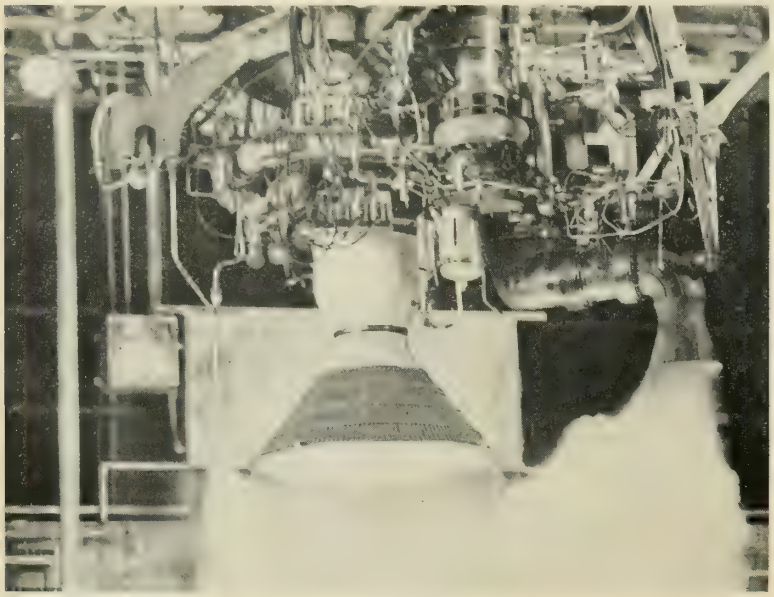
RIGHT: *Firing of 1/6th scale model held in place about 80% of the way up silo tube shows engine exhaust exiting from either side of "W" deflector.*

Titan II Development Cost One-Third

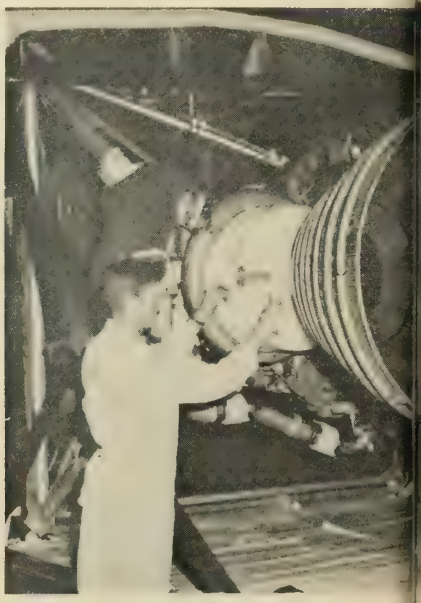
SUCCESSFUL flight of the first storable-fueled ICBM, the Titan II, capped an Aerojet-General engine development effort accomplished in half the time and at a third of the cost of its predecessor Titan I.

Aerojet-General spokesmen credit this to the Air Force investment in the Titan I technology. Despite the speed and low cost of the development, the Titan II engines are more reliable—they have only one-third as many moving parts as their cryogenic forerunners.

Titan II is slated to be the booster in NASA's Gemini program. The missile will be the core of the Titan III, a composite, solid-liquid booster workhorse.



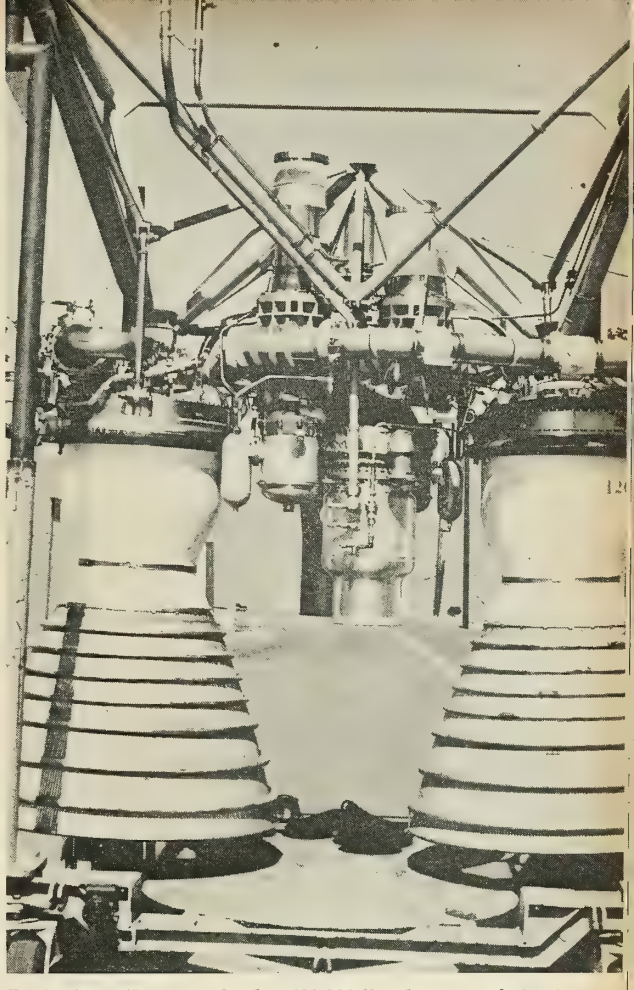
EXHAUST FROM the single-roll control nozzle in the second stage is seen at right. Fuel overboard line discharging actuator-used fuel is visible to the left.



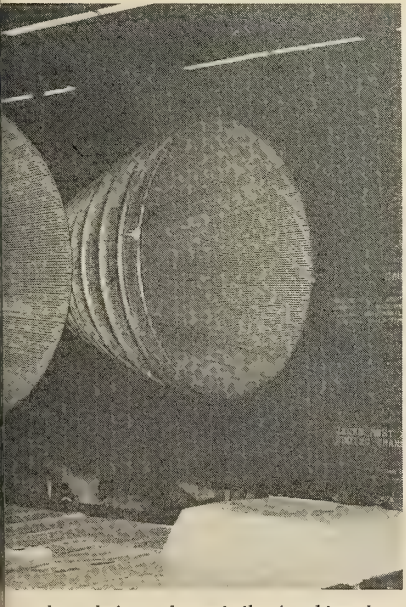
FINAL PACKAGING of ICBM first-stage engine is handled at Aerojet's Sacramento

# of Titan I's

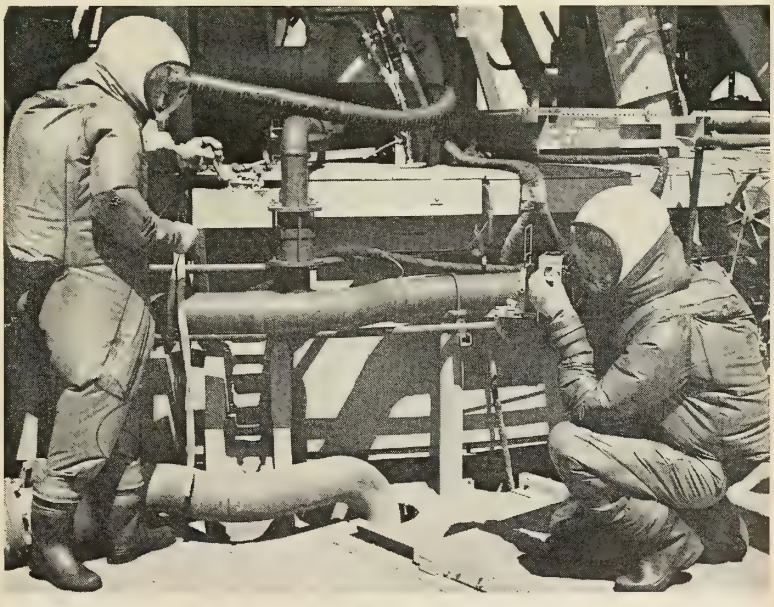
Because of the storable fuels, little or no countdown is necessary in operational firings. The flight down the Atlantic Missile Range on March 16 was preceded by a countdown for tracking and other system integration purposes. The ICBM is designed for quick response launchings from underground silos.



FIRST-STAGE engines develop 430,000 lbs. thrust, yet design is far simpler than that of 300,000-lb. Titan I engines.



plant before the missile is shipped to Martin-Denver, Titan prime contractor.



BUTYL-COATED cotton safety suits are worn by servicing personnel at the launch site. The suit weighs five lbs. and carries a 15-lb. life support pack.

Electric Tops for High-Energy Trips

JPL study shows 45,000-lb. craft would far surpass chemical or nuclear-heat-exchanger spaceships

AN ELECTRICALLY propelled spacecraft with an initial weight of 45,000 lbs. can perform every one of the 15 high-energy missions of interest to space scientists.

Scientists from the Jet Propulsion Laboratory, California Institute of Technology, told the recent Electrical Propulsion Conference of the American Rocket Society that comparable chemical and nuclear-heat-exchanger spacecraft can handle only seven and nine of these, respectively.

JPL has been studying deep-space applications of electrical propulsion engines for nearly two years. The main problem lies in the power sources. L. D. Jaffe, J. I. Shafer, O. S. Merrill, J. W. Lucas and D. F. Spencer—coauthors of the ARS paper—concluded that a highly accelerated research and development program is warranted for both thermionic and turbogenerator powerplants.

The JPL scientists, taking into account what they consider to be realistic estimates of system weight, report that these two powerplants appear to have comparable specific weights—12 to 14 lb./kwe at the 0.3 to 1.5 Mwe power level.

Systems considerations indicate that the static or thermionic type may be preferred. For instance, attitude-control requirements of the spacecraft are minimized with this system, through elimination of rotating mechanical devices, and the radiator area is reduced.

But the most important factor is the inherent reliability associated with a static system. The JPL experts say this reliability can be demonstrated in ground testing.

• **Reasonable definition**—Studies at JPL have progressed far enough so that preliminary information is yielding some pertinent conclusions.

In its analysis, JPL took the gross payload as being the weight of the spacecraft at its destination, less the propulsion powerplant weight. This includes the weight of scientific instruments, telecommunications, guidance and control and associated structures. The powerplant weight is in terms of its electrical gross power level and specific weight.

The discussion excluded secondary power; it was confined to an electric propulsion system consisting of a nuclear reactor feeding a power conversion system, dynamic or static, and an electrical propulsion unit with associated tankage and controls.

Performance calculations were based on ion thrust units, but the power-conversion system is equally applicable to other electric concepts.

The *Nova* was conceived as a first stage by the JPL researchers. Six F1 engines are topped by liquid oxygen-hydrogen upper stages.

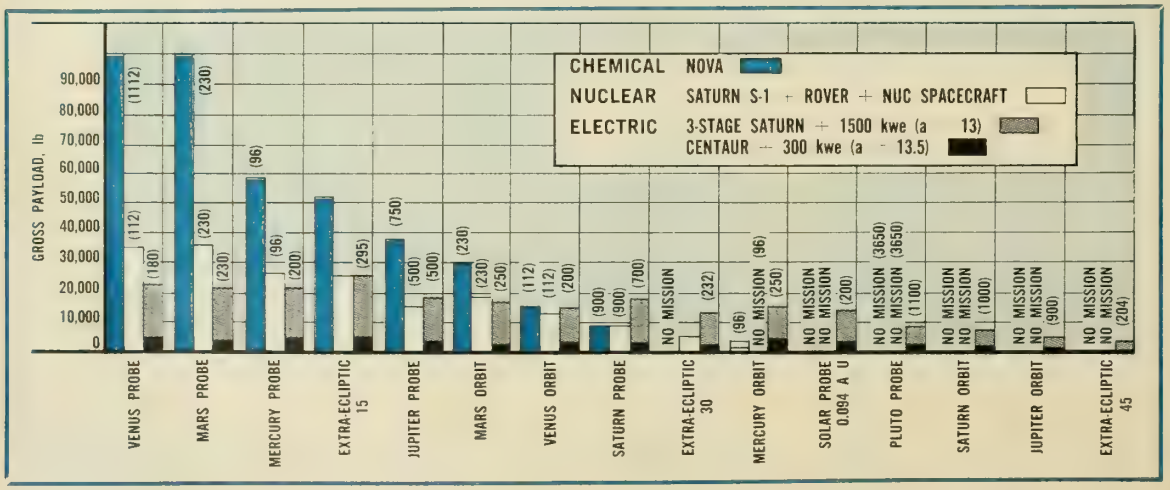
The electric missions were computed by using constant thrust directed tangentially in the spiral trajectories and an Irving and Blum optimum-thrust program in the heliocentric trajectory. Payload weights are therefore optimistic by 5-10%.

The vehicles studied include:

—The chemical *Nova*, capable of 300,000 lbs. in a 300-n.-mi. Earth orbit.

—The *Saturn* nuclear vehicle, utilizing a *RIFT*-type reactor stage aboard the *S-1* and estimated to have a payload capability of 79,000 lbs. in Earth orbit.

—Electric vehicles having an 8500-lb. initial weight in 300-n.-mi. orbit, with a 300 kwe powerplant and a 45,-



MISSION CAPABILITY comparison chart covers gross payload estimates for 15 planetary and interplanetary missions of interest to space scientists. Designation "no mission" signifies either that the propulsion system is incapable of delivering any weight to its destination, or that the gross weight is less than required for necessary associated equipment and minimum experiments.

000-lb. initial weight in orbit with a 1500-kwe powerplant.

The combined weight of temperature control, guidance systems, etc., was taken as 1000 lbs. For the chemical and direct nuclear systems, an additional 500 lbs. was allotted to the telecommunication power supply.

In the case of the nuclear systems, allowance has been made for thrust and interstage structure in the dead weight —an additional 500 lbs., the estimated weight of spacecraft structure for the electric and chemical systems, must be deducted in their cases to present the results on a comparable basis.

For example, the JPL experts say a useful mission with a chemical system must involve a gross payload of at least 2000 lbs. At least 1500 lbs. is predicated for nuclear or electric systems.

• **Electric biggest potential** — The *Nova* has greater payload potential for low- and medium-energy missions, whereas the electric systems are superior for high-energy missions. "The nuclear heat exchanger systems on the *Saturn S-1* stage nowhere play a singular role in the unmanned exploration of planetary and interplanetary space," say the JPL scientists.

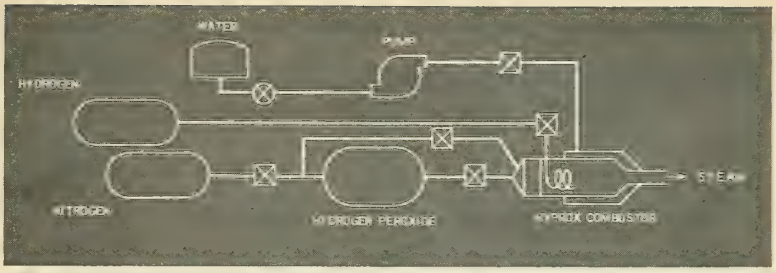
Vehicle Capacity for 15 missions

Vehicle type	Number of Missions		
	Not Feasible	Marginal	Definitely Feasible
Chemical Nova	7	0	8
S-1 + 2 nuclear stages	6	0	9
300 kwe electric (= 13.5 lb./kwe) 8500 lb. initial wt.	3	3	9
600 kwe electric (= 13.5 lb./kwe) Saturn C-1 (20,000 lb. initial wt.)	1	0	14
1500 kwe electric (= 13.0 lb./kwe) 45,000 lb. initial wt.	0	0	15

A summary of the mission capability of the four vehicles covered in the bar chart with the addition of a 600 kwe electric system for use with a Saturn C-1. Not Feasible refers to payload definitely under the gross limits mentioned above. Marginal covers those systems capable of delivering a payload within 1000 lbs. of minimum and Definitely Feasible covers system with capabilities greater than the other two.

The 1500-kwe electric system of 45,000 lbs. initial weight is capable of performing all indicated missions; there is therefore a strong incentive for producing such a unit.

The JPL scientists included *Saturn C-1* to indicate the type of performance possible for an intermediate power level with an assumed cluster of two 300-kwe powerplants. If it is impossible to obtain a vehicle in the 45,000-lb. class, the *Saturn C-1* would permit 13 and possibly 14 of the missions to be performed. ⁂



Small 'Hyprox' Generators Boast High Steam Flow Rate

Thiokol's Reaction Motors utilized parts from early XLR-99 engines to make low-cost, quick-acting units

A STEAM GENERATOR no bigger than a man but capable of producing up to 3.5 million lbs./hr. of steam at pressures up to 2000 psi has been developed by Reaction Motors Division, Thiokol Chemical Corp.

The "Hyprox" units will achieve this —without standby service—within 15 seconds of the initial start signal.

The device is aimed at military and civilian markets in which primary considerations are low installation cost, high flow rate and instant steam demand at intermittent levels. These applications include altitude simulation, cryogenic sub-cooling, intermittent vacuum or steam ejector drives, and pilot-plant operations.

The Hyprox generator operates on hydrogen peroxide, gaseous hydrogen and water to produce the steam. The H_2O_2 is catalytically decomposed to produce superheated steam and free oxygen at its decomposition temperature of 1380°F. Gaseous hydrogen is next introduced to burn with the free O_2, generating additional steam. The resultant mixture is pure steam with a temperature of approximately 4500°F.

Water is then added to produce more steam and reduce the superheat to saturated dry steam or to any desired degree of wet-quality steam.

• **Steam rocket**—The operating sequence starts with the introduction of a small quantity of H_2O_2 into the catalyst bed. After this preheating step, full peroxide flow is initiated. The gaseous hydrogen is partially diverted through a pre-heat coil submerged in the decomposed peroxide stream, permitting spontaneous burning with the oxygen without ignition devices.

Water enters the unit through a cooling jacket, increasing its own enthalpy by heat transfer, and is ejected in sufficient quantity to generate the desired quality of steam. Automatic pre- and post-operation controls purge the Hyprox system completely.

Steam temperature is instantly regulated by "dialing in" the proper water injection rate. All controls and valving are integrally mounted on the Hyprox package. All generators, and their associated support systems, are designed and manufactured to ASME and ASA specifications for fired and unfired pressure vessels.

Part of the history of this family of generators is associated with the XLR-99 variable-thrust rocket engine, developed by the division for the *X-15* program. Some of the hardware in the prototype steam units was salvaged from early XLR-99 engine firings.

The Hyprox units run in size from 40,000-lb./hr. units to 3.5 million lbs./hr. The required floor space is between 4 and 64 sq. ft. This is considerably smaller than the area occupied by water-tube steam generators of the same capacity.

All of the units are equipped with fail-safe controls. Each unit is completely automatic in starting and delivers on-the-line steam at the flick of a switch.

The auxiliary system includes a peroxide supply, a water source, hydrogen bottle cascades with associated manifolds and regulators, and a small nitrogen bottle bank for purging. None of the equipment and buildings normally associated with conventional steam plants are required. ⁂

Program To Get $10 Million for R&D

FIRST IRIS sounding rocket—launched July 22, 1960, from Wallops Is., carried 150 lbs. of instruments to 140-mi. altitude in performance checkout.

by William Beller

THE NATION'S sounding rocket program is expected to be funded at $10 million for research and development during Fiscal Year 1963—a substantial increase over the $7 million budgeted for the purpose for the current fiscal year.

The funding level would apparently have gone even higher if some of the investigations seemingly suited to vertical probes had not been recast for satellites. Nevertheless, the unique scientific value of sounding rockets is seen maintaining the national program level close to the Fiscal '63 figure for the next few years.

• **Rockets vs. satellites**—The civilian space agency's Goddard Space Flight Center about three years ago set up the sounding rocket program chiefly for two reasons: to help get scientific data for geophysical and astronomical studies; and to have an inexpensive way to test under space-like conditions some of the equipment destined for satellites.

When the program was started, Goddard scientists expected that university and industry investigators would use about 80% of the total payload of scientific rockets; in-house scientists would take the rest. This did not happen.

During the program's first two years, only 53 of the 144 rockets fired were for out-of-house programs. The scientific work still had to be done but university and industry scientists seemingly were being drawn more toward satellites than vertical probes. In many instances, the glamour of having an experiment aboard an orbiter did not play a part in the decisions.

Meanwhile, Goddard is encouraging universities and industry to take advantage of the rocket probe program and the many scientific benefits it offers. The low-key campaign has been somewhat successful, and increasing numbers of out-of-house proposals are being received and accepted.

• **New rockets**—Last year the National Aeronautics and Space Administration fired 70 sounding rockets, principally from its Wallops Island facility. Launchings were also made from Fort Churchill, Canada, and from Australia's Woomera range.

Two new rockets were introduced during 1961: the *Nike-Apache,* launched May 25 from Wallops on the first of a string of five successful; and Bristol's *Skylark,* launched successfully four times (which comprised its program with NASA).

Goddard is scheduled to buy five *Aerobee 350's* in the next fiscal year. This Space-General rocket is expected to lift a 150-lb. payload to an altitude of 350 miles. The Center is also planning to buy two *Astrobee 1500's* as replacements for *Argo D-8's.* The two-staged *Astrobee* will have about the same performance as the four-staged *D-8* but will tend to have better reliability because of the fewer stages.

The Navy is developing the *Archer* rocket-system to make synoptic measurements of solar radiations. Using an Atlantic Research motor, the vehicle is in part being supported by NASA, which hopes to use it as a vertical probe able to carry 40 lbs. to a 100-mile altitude.

• **Help needed** — The sounding rocket program calls for sending vertical probes as far out as one earth's radius. Goddard has exploited only a small part of this charter and is currently looking for better ways to fulfill it.

"We have a requirement for a rocket that will carry 100 to 125 lbs. to about 300 miles' altitude and which will allow us to recover the payload," says Karl Medrow, head of Goddard's Sounding Rockets Instrumentation Branch.

Another requirement is for a rocket able to reach 3000 miles' altitude with a 250-lb-payload. The payload must be able to re-enter without burning, so that it can be recovered. Such a vehicle would be used to send aloft nuclear emulsion packages and biological specimens.

Medrow said he could not overemphasize the need for a way to recover the payloads. A successful method calls for a predictable trajectory plus a slow terminal descent probably by parachute or balloon.

The problems that arise are illustrated by last November's two *BIOS* firings: launched by an *Argo D-8* rocket, the *BIOS I* capsule—designed to determine the effects of radiation belts on living matter—went only halfway down range; and the backup *BIOS*

II did not achieve full altitude. Consequently, the fleet of ships poised to rescue the *BIOS* payloads—85-lb. capsules parachuting into the sea—failed to find them.

"It would help tremendously if we could guide the rockets," says Medrow. He pointed out that NASA's sounding rockets are unguided, the fins used not for control but for aerodynamic stability. He repeated, "We need a *cheap*, lightweight system—and anybody who has one, we surely want to see it."

• **There's payload room**—Goddard is eager to get industry as well as many more university scientists participating in the sounding-rocket program. "We'd like to have the institutions make proposals and if they're good ones and the exploratory types, we're sure they'll be approved and we'd be delighted to carry them." He sadly noted that even now few universities seem to be interested.

Industry is welcome to suggest experiments too, and once proposals are submitted to Goddard, Medrow indicated they will be speedily examined and acted upon. Moreover, "We try to carry industrial and university 'hitchhikers' whenever possible, and there is no charge for this service if the experiments hold promise of contributing to basic research."

• **Why vertical probes?** — Even though the sounding rocket has a short life in space, it is described as a powerful and unique scientific instrument for upper atmospheric research:

—The sounding rocket is the only vehicle that can make effective scientific investigations in the region from 20 to 100 miles above the earth.

—It can get preliminary geophysical and astronomical data which, in turn, can be used as a guide for developing more sophisticated experiments, perhaps with satellites.

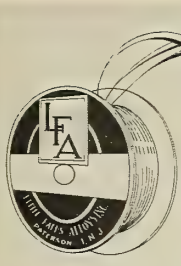
—Sounding rockets can also test prototype instrumentation which later will be used in satellites.

—A scientist can send a sounding rocket up to make measurements at the time and place, within limits, he wants.

—For certain experiments, the sounding rocket is selected because of the relative ease and low cost of payload recovery operations. However, when satellite recovery operations are improved the situation may change.

—Unlike current satellites, sounding rockets can carry relatively large power supplies.

Goddard is working toward a family of probes that will be able to make cheap and simple vertical soundings in the territory beneath the lowest satellite. When these vehicles are devised, and their payloads are recoverable with regularity, then NASA will be ready more fully to explore and exploit a vast new field. ❖



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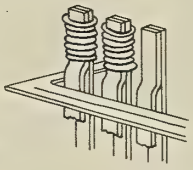

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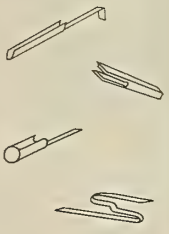

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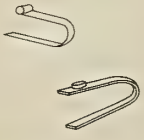

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3 — American Helicopter Society
4 — Armed Forces Day
5 — Navy League
6 — Air Force Association
7 — Association of the U. S. Army
8 — National Defense Transportation Association
9 — American Rocket Society

X = Participation ? = Undecided

Company	1	2	3	4	5	6	7	8	9
Aerojet-General	X	X	No	No	X	No	?	No	X
Aeronutronic, Div. of Ford	X	No	No	No	No	No	?	No	No
Aluminum Co. of America	X	No	No	No	No	No	No	No	?
American Brake Shoe Co.	No	No	No	No	No	No	No	No	No
Avco Corp.	No	No	X	No	No	No	X	No	X
Bell Aerospace Corp.	No	No	X	X	No	X	X	No	?
The Bendix Corp.	No	No	X*	No	No	No	No	No	No
The Boeing Company	X	No	?	No	No	No	No	?	No
Cessna Aircraft Co.	No	No	X	X	No	No	No	No	No
Continental Motors Corp.	No	No	X	?	No	X	X	No	No
Curtiss-Wright Corp.	No	No	No	X	No	X	X	No	X
Dallas Airmotive Inc.	No	No	No	No	No	No	No	No	No
Douglas Aircraft Co.	No	No	No	No	?	?	?	No	?
The Garrett Corp.	No	No	X	No	No	No	X	No	No
General Dynamics Corp.	?	?	?	?	?	?	?	?	?
General Electric — Cincinnati	No	No	?	?	X	?	?	No	?
General Electric — Schenectady	X	?	X	?	X	X	X	?	X
General Motors — Allison Div.	No	No	X	No	No	No	No	No	?
General Precision, Inc.	No	No	No	No	X	X	No	No	No
B. F. Goodrich	No	No	No	No	No	No	No	No	X
Goodyear Aircraft Corp.	No	X	No	No	No	No	X	No	X
Grumman Aircraft Engrg. Corp.	No	No	X	X	X	X	X	No	?
Gyrodyne Co. of America	?	No	?	No	No	No	?	?	No
Hiller Aircraft Corp.	No	X	X	No	No	No	X	No	No
Hughes Aircraft Co.	No	No	No	No	No	No	No	No	No
IBM Corporation	X	No	No	No	X	X	X	No	X
The Kaman Aircraft Corp.	No	No	X	X	No	No	No	No	No
Lear, Incorporated †	No	No	No	No	No	?	No	No	X
Ling-Temco-Vought Inc.	No	No	No	No	No	No	No	No	No
Lockheed Aircraft Corp.	No	X	No	No	X	X	X	No	No
The Marquardt Corp.	No	No	No	No	No	?	No	No	X
Martin Co. — Div. Martin Marietta	No	X	No	X	X	X	X	No	X
McDonnell Aircraft Corp.	No	No	No	X	?	?	No	No	No
Minneapolis-Honeywell	No	No	No	?	No	?	No	No	?
North American Aviation Inc.	No	X	No	X	X	X	X	No	X
Northrop Corporation	No	No	No	No	No	No	No	No	No
Republic Aviation Corp.	No	No	X	?	?	?	?	?	X
Rohr Corporation	X	No	No	No	No	No	No	No	No
Ryan Aeronautical Co.	No	No	No	X	X	X	X	No	X
Solar Aircraft Co.	?	?	?	?	?	?	?	?	?
Sperry Gyroscope Co.	No	No	No	X	No	X	X	No	X
Thiokol Chemical Corp.	No	No	No	No	No	No	No	No	X
Thompson Ramo Wooldridge	No	?	No	X	X	No	X	No	X
United Aircraft Corp.	No	No	X	X	No	No	No	No	X
Westinghouse Electric Corp.	No	No	No	No	No	No	No	No	No

* Four divisions participating.
† May change in the event of Siegler-Lear merger.

Survey Shows Firms Cutting Exhibit Plans

A STRONG downward trend in industry participation in trade shows and exhibits is disclosed in a survey by the Aerospace Industries Association.

AIA queried its members on plans for participation in nine industry events scheduled for this year. Voting showed an overwhelming sentiment against participation. Not all major shows were included in the query.

Some 45 firms or divisions responded to the poll. There were 255 negative votes, 94 affirmative, and 56 undecided.

Not one show attracted a majority of the firms replying. Of the two receiving the most affirmative votes—the American Rocket Society meeting in Los Angeles in November and the Air Force Association meeting in Las Vegas in September the ARS came closer to an even split: 17 firms said they plan to participate in the ARS exhibit; 19 said they do not. Nine were undecided.

The voting indicated a 2-to-1 sentiment against participation in the AFA exhibit. There were 24 negative answers, 12 affirmative and 9 undecided.

Preliminary returns clearly show a trend.

A major factor working against company participation in trade shows and exhibits this year has been Congressional and Department of Defense action revising the allowability clause for exhibits. These no longer can be written off as a contract cost item.

Another factor has been a congealing of industry sentiment against participation. Representatives of many firms have questioned its value.

AIA itself late last year urged its members to avoid costly exhibits.

Replies to the AIA poll show the following totals as of March 20:

Seattle World's Fair, 7 yes, 35 no, 3 undecided; Western Space Age and Engineering Exposition, 6 yes, 35 no, 4 undecided; American Helicopter Society, 13 yes, 27 no, 5 undecided; Armed Forces Day, 12 yes, 26 no, 7 undecided; Navy League, 12 yes, 29 no, 5 undecided; Air Force Association, 12 yes, 24 no, 9 undecided; Association of the U.S. Army, 16 yes, 21 no, 8 undecided; National Defense Transportation Association, 0 yes, 39 no, 6 undecided; American Rocket Society, 17 yes, 19 no, 9 undecided.

(See editorial, p. 46)

The Industry Week

Martin Procurement Widespread

The Martin Co. spent almost a third of its $371.4 million in purchases last year with small businesses, which accounted for some three-quarters of the company's suppliers. California received the largest share of procurement dollars—more than $62.4 million. New York was second with $58.6 million.

New Names in the Industry

Bellcom, Inc. has been formed to supply system engineering support to the U.S. space flight program. The corporation, announced by the Bell Telephone Labs, is owned jointly by AT&T and the Western Electric Company. The organization will provide NASA with system studies and technical facts to be used in making decisions in the manned flight program. . . . *Physics Technology Laboratories has been organized in San Diego, Calif., as a basic and applied R&D company. The firm will conduct studies in astrophysics and other fields, including solid-state, plasma, nuclear, surface, atomic, and electron physics.* . . . Siliconix Inc., was formed in Sunnyvale, Calif., to manufacture and market integrated electronic circuits and other semiconductor products. The company was formed by a group of semiconductor scientists at the Electronic Engineering Co. of Calif., and the Baldwin Piano Company. . . . *Sulfrian Cryogenics, Inc., has been founded in Hillside, N.J., as an engineering and manufacturing organization, operating exclusively in the low-temperature field. The company will produce liquefied and atmospheric gases and high-vacuum storage and transport containers for use with liquid gases.*

News of Mergers and Acquisitions

Marshall Industries, San Marino, Calif., acquired Preston Scientific, Inc., a digital instrument manufacturer. Preston will operate as an autonomous subsidiary of Marshall. . . . *Allied Research Associates, Inc., directors approved acquisition of Radiation Counter Labs, Inc., Skokie, Ill. Both firms have been engaged in the nuclear instrumentation field.* . . . Globe Electronics Co. has merged with G. C. Electronics Co., Rockford, Ill. . . . *Airaterra and Roylyn, Inc. have consolidated, with Roylyn becoming a wholly owned subsidiary of Airaterra. The firms do R&D, design and production of aerospace hardware.* . . . Resistoflex Corp., Roseland, N.J., acquired Zallea Bros., Wilmington, Del., producer of metal expansion joints for the chemical and process industries. . . . *The Cosmodyne Corp., Hawthorne, Calif., purchased total assets of A & S Allen & Sons, Paramount, Calif.*

New Industry Facilities

Raybestos-Manhattan, Inc., will occupy a new plant at Manheim, Pa., this month in an expansion move to meet increased demand for the company's reinforced plastic materials and insulators in the missile/space industry. . . . *Cryogenics, Inc., relocated its management, administrative and marketing staffs to make more manufacturing space available.* . . . Arwood Corp. opened a fully integrated investment casting foundry in Cleveland. . . . *Joseph Kaye & Co., Inc., Cambridge, Mass., established a manufacturing division to produce thermoelectric devices for industrial and laboratory applications. Kaye is a consulting, research and development firm in fluid flow, thermodynamics, and thermoelectricity.* . . . Douglas Aircraft Co. formed Vortec Products Co., Long Beach, Calif., to develop, manufacture and market products using principles of fluid dynamics. . . . *Daystrom, Inc., is expanding its Worcester, Pa., Transicoil Div.* . . . Maxson Electronics Corp. is building laboratory and production facilities at Great River, L.I., N.Y. The buildings will contain 225,000 sq. ft. of floor space. . . . *Aero Mechanism, Inc., manufacturer of pressure-sensing devices, moved to larger facilities in Van Nuys, Calif.* . . . Contronics, Inc., Boston, is building a new facility in Tewksbury, Mass. . . . *U.S. Time Corp. is constructing a new building in Irvington-on-theHudson, N.Y., to house expanded R&D facilities including controlled lab areas for highly precise gyroscopic mechanisms.* . . . Electro-Optical Systems, Inc., broke ground for a new $2.2-million R&D facility at Pasadena, Calif. Divisions to be housed in the new complex will include Advanced Power Systems, Solid State, Advanced Electronics and Information, and Quantum Physics. Specialized facilities for space hardware development include environmental test devices to simulate temperature, vibration and shock, and special rooms which are dust-free and humidity- and temperature-controlled. . . . *The Mitre Corp. formed two new departments, Tactical Systems and Strategic Systems. Tactical Systems will work on peacetime, cold war and limited war planning operations. Strategic Systems will be mainly concerned with Strategic Air Command and Control Air Command and Control System.*

International News Briefs

Varian Associates, Palo Alto, Calif., and Compagnie Française Thomson-Houston, Paris, announced plans to create a jointly owned microwave tube company in France. The new firm, Thomson-Varian, will concentrate on the European market and is expected to emphasize its klystron tube capabilities. The French parent firm will hold 51% interest in the company. Operations are expected to begin July 1. . . . *Sweden's contribution to the European Space Research Organization will be $16 million, or 5% of the total cost. Kiruna in North Sweden is reportedly favored as suitable for a high-altitude rocket base. Installations proposed include the rocket base and a satellite observation station.* . . . Norton Co., Worcester, Mass., purchased controlling interest in an English machine tool plant for manufacture of its grinding and lapping machines. The facility, R. Woodvine and Son, Ltd., is located in Shrewsbury, about 160 miles from London. . . . *National Research Corp. established a sales office in Geneva, Switzerland.*

contracts

AIR FORCE

$22,300,000 — **American Machine & Foundry Co.**, Greenwich, Conn., for work on *Titan I* launching system and for research and development for *Titan I* and *II* plus related ground and support equipment.

$12,000,000—**Thiokol Chemical Corp.**, Bristol, Pa., for production of *Minuteman* motors and related material (supplemental contract).

$7,550,000 — **Aerojet-General Corp.**, Sacramento, Calif., for research and development for the *Minuteman* Stage II motor supplemental contract).

$7,000,000—**Sperry Gyroscope Co.**, Great Neck, N.Y., for instrumentation of C-4 ships to use on the Atlantic Missile Range (supplemental contract).

$6,582,030 — **General Dynamics Corp.**, San Diego, Calif., for procurement of equipment and manufacture of *Atlas* boosters in support of *Nike-Zeus* program (2 contracts).

$6,000,000—**Radio Corp. of America**, Burlington, Mass., for final-stage vehicles and services in support of a satellite program

$4,900,000—**Hercules Powder Co.**, Wilmington, Del., for research and development for the Stage III *Minuteman* motor.

$4,837,000—**Philco Corp.**, Palto Alto, Calif., for activities connected with the satellite control subsystem program.

$4,692,876—**Lockheed Aircraft Corp.**, Sunnyvale, Calif., for equipment and related items for a space satellite communications and controls system and for research and development for space satellite vehicle programs (2 contracts).

$4,530,090 — **General Dynamics Corp.**, San Diego, Calif., for provision of launch support and related services to space satellite programs (supplemental contract).

$3,788,000 — **Pan American World Airways, Inc.**, New York City, for an increase in funds to contract AF 08(606)-3413, 23 Feb. 62.

$3,400,000 — **General Dynamics Corp.**, San Diego, for engineering design, development and fabrication of *Atlas* boosters for space programs and for provision of ground equipment, spare parts and special tools during installation and checkout of *Atlas* missiles (2 contracts).

$3,230,000—**General Electric Co.**, Philadelphia and Pittsfield, Mass., for work on Project *Advent* and for four radar antennas for use in the MISTRAM precision missile trajectory measurement system.

$2,500,000 — **General Electric Co.**, Syracuse, N.Y., for two each radomes installed to protect radar antennas.

$2,434,181—**Cutler-Hammer, Inc.**, Deer Park, N.Y., for production of an electronic countermeasures system.

$1,918,850 — **Aerospace Corp.**, El Segundo, Calif., for providing systems engineering, technical direction and management services for ballistic missile and space programs (supplemental contract).

$1,887,936 — **Dow Chemical Co.**, Midland, Mich., for development and evaluation of solid propellants.

$1,500,000—**Philco Corp.**, Palo Alto, Calif., for activities in connection with the satellite program (supplemental contract).

$1,404,000—**Martin Marietta Corp.**, Denver, for services connected with activating *Titan* sites at Buckley ANG Base, Colo.

$1,306,000 — **Electro-Optical System, Inc.**, Pasadena, Calif., for applied research and development of a cesium contact ion engine.

$1,300,000—**Federal Electric Corp.**, Paramus, N.J., for installation of an interim tropospheric scatter communications system (supplemental contract).

$1,200,000—**General Telephone and Electronics Corp.**, Mountain View, Calif., for a miniature electronic security system for the *Minuteman* program, work to be done by the Reconnaissance System Laboratories of Sylvania Electric Products, Inc.

ARMY

$4,263,255 — **Hayes International Corp.**, Birmingham, Ala., for continued production of *Pershing* missile trainers and for components for the trainers.

$3,782,080—**Western Electric Co.**, Burlington, N.C., for repair parts to support improved radar equipment for the *Hercules* missile system.

$1,920,000 — **Martin Marietta Corp.**, Martin/Orlando, Fla., for *Pershing* missile trainers.

$1,753,780—**The Bell Aerosystems Co.**, Buffalo, N.Y., for development of air and ground equipment for the *USD-1* drone.

$1,545,723 — **The Jan-Mar Construction Co.**, Golden Valley, Minn., for construction of a missile assembly building at Vandenberg AFB, Calif.

$1,165,861—**Curtis Wright Corp.**, Wooldridge, N.J., for production of rocket motor cases for the *Pershing* missiles.

$1,000,000 — **Pan American World Airways, Inc.**, New York City, for facilities for development and testing of advanced surveillance systems, work to be performed at Tucson, Ariz.

$961,718—**Sperry Rand Corp., Sperry Utah Co.**, Salt Lake City, Utah, for research and development efforts on *Sergeant* missile system.

$915,000 — **Page Communications Engineers, Inc.**, Washington, D.C., for maintenance and operation of the Pacific Scatter Communication System.

$438,620—**The Bendix Corp., Friez Instrument *Div.***, Baltimore, for radiosonde sets and modifications.

$298,000 — **Western Electric Co.**, New York City, for procurement of repair parts for *Nike-Hercules* missile system.

$100,000—**Rocket Power, Inc.**, Mesa, Ariz., for *Pima* drone booster rocket motors.

INDUSTRY

$8,000,000 — **Avco Corp., Research and Advanced Development Div.**, Wilmington, Del., from **North American Aviation**, for designing and building the heat shield for the *Apollo* spacecraft.

$1,000,000—**Minneapolis-Honeywell Regulator Co., Aeronautical Div.**, Minneapolis, from **North American Aviation**, for gyroscopes for the *Minuteman* ICBM inertial guidance systems.

NAVY

$6,250,000—**The Ryan Aeronautical Co.**, San Diego, Calif., for augmentation and ground support equipment and spares for the *Q-2C Firebee* missile and for *Firebee* ground support equipment and launch facilities for Naval bases at Pt. Mugu, Calif., China Lake, Calif., and Naha, Okinawa.

$5,603,000 — **Raytheon Co.**, North Dighton, Mass., for AN/SPG-51 tracking radar for *Tartar* missile fire control systems.

$4,000,000—**Radio Corp. of America, Defense Products Division**, Camden, N.J., for classified electonics equipment.

$3,575,000—**Lockheed Missiles and Space Co.**, Sunnyvale, Calif., for *Polaris* missile supsified electronics equipment.

$2,140,000—**Thiokol Chemical Corp.**, Bristol, Pa., for liquid-propellant rocket engines for *Bullpup* missile.

$2,068,487—**Elgin National Watch Co.**, Los Angeles, for fuzes for *Bullpup*.

$1,221,411 — **Aerojet-General Corp.**, Sacramento, Calif., for research and development for advanced propellant upper-stage rocket motors (definitive contract).

$706,207—**The Martin Marietta Corp.**, Baltimore, for engineering and productivity program for a microwave command-link which will be compatible with the *Bullpup* weapon system.

$437,947—**Corps Construction, Ltd.**, Kailua-Kona, Hawaii, for Pacific Missile Range facilities, Hawaiian tracking station, South Point Kau, Hawaii.

$431,906—**Aerojet-General Corp.**, Azusa, Calif., for rocket and boosters.

$327,540 — **General Electric Co.**, Washington, D.C., for conducting a preliminary program of research and development of the ion-exchange membrane fuel cell, using the reactants hydrogen and oxygen, for ultimate application as a submarine propulsion plant.

NASA

$8,910,962—**The Boeing Co.**, Seattle, for initial work on the first-stage rocket booster for the advanced *Saturn*.

$1,000,000—**Marshall Industries, Aerolab Development Co.**, Pasadena, Calif., for multistage *Argo* series rockets (joint contract with Army and Air Force).

$359,000—**Compudyne Corp.**, for services and materials design, fabrication and installation of two electro hydraulic model positioning systems for Mach 10 and Mach 20 helium blowdown jets of the hypersonic aerothermal dynamics facility.

$300,000—**The Bendix Corp., Bendix-Pacific Div.**, North Hollywood, Calif., for a telemetry playback system for space flights.

$288,800—**Jered Industries, Inc.**, Birmingham, Mich., for designing, furnishing and installing a space vehicle rendezvous docking simulator.

$255,680—**Astronautics Div., Chance Vought**, Dallas, for design studies preparation of design specifications.

AERO DYNAMICIST

CAREER APPOINTMENT

The Applied Physics Laboratory of the Johns Hopkins University publishes the HANDBOOK OF SUPERSONIC AERODYNAMICS under cognizance of the U. S. Navy. APL now wishes to appoint an Aerodynamicist to its technical staff to critically review, edit, and occasionally rewrite manuscripts for this publication. The appointment is permanent.

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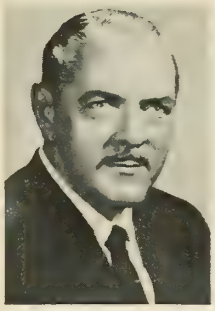
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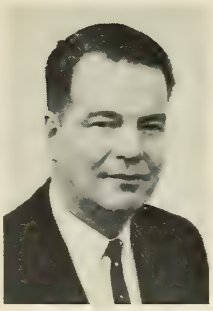

WHITESIDE

ANTONIO

Harry L. Brown: Former director of manufacturing of the Aero Div., Minneapolis-Honeywell, St. Petersburg, Fla., has been brought into Guidance Technology, Inc., Santa Monica, Calif., as vice president-engineering.

A. J. Quackenbush: Appointed director of corporate planning and control in the Douglas Aircraft Co., Santa Monica, Calif.,

John E. Ebert: Former vice president of FXR, Inc., has joined Weinschel Engineering Co., Kensington, Md., as vice president in charge of research, development and engineering.

James H. Green: Has been made director of telecommunications systems at Page Communications Engineers, Inc., a subsidiary of Northrop Corp., Washington, D. C.

M. Robert Rowe: Named manager of Commercial Engine Operation, Flight Propulsion Division, General Electric Co.

George A. Whiteside: Has joined Wiancko Engineering, a division of Tamar Electronics, Inc., as vice president and general manager.

Albert Boczan: Will fill the new post of chief design engineer in Hopkins Engineering Co., San Fernando, Calif.

Russ B. Walworth: Formerly with Electronic Communications, Inc., has been appointed vice president for sales of Burnell & Co., Inc., Pelham, N. Y.

Marvin Schweiger: To direct advanced program in pure fluid systems at Bowles Engineering Corp., Silver Spring, Md., has been brought into the firm as vice president in charge of research and development.

Richard L. Shelter: General manager of General Electric's Defense Systems Department, elected to the board of directors of Apparatenindustrie Defense Electronics, N.V., the Hague, Netherlands, a subsidiary of G.E.

Dr. Adolph L. Antonio: While continuing as a staff vice president of Aerojet-General Corp., will assume the duties of vice president and general manager of the Space-General Corp., Glendale, Calif., a subsidiary of Aerojet-General.

Col. Kenneth E. Hill: Newly assigned commander of the 4751st Air Defense Wing (Missile), Hurlburt Field, Fla., upon the transfer of the former commander, **Col. Joseph Myers,** to the post of assistant deputy for personnel at Air Defense Command Headquarters.

Dr. Bernard R. Linden: Promoted to vice president of the Special Electron Tube Department, CBS Laboratories, Stamford, Conn.

Dr. Ruben F. Mettler: Elected to the office of president and chief executive officer of Space Technology Laboratories, Inc., Redondo Beach, Calif.

Arthur F. Collins: Founder of Collins Radio Company, has been presented with the U.S. Navy's highest civilian award, the "Secretary of the Navy's Distinguished Public Service Award Citation," for giving "unstintingly of his time and genius in helping the Navy to maintain its leadership in the complex areas of airborne communications, electronic navigation and high-speed data transmission."

A. Robert Masters: Promoted to the post of Executive vice president of the Hugh H. Eby Co., Philadelphia.

L. L. Waite: Senior vice president, engineering-planning, has been made Senior vice president, contracts and programs of North American Aviation, Inc., Los Angeles. At the same time **Dr. Marvin Stern** was named vice president, research and engineering.

Dr. Donald B. Brick: Appointed to fill the new position of senior scientist of Sylvania Electric Products Inc., Applied Research Laboratory, Waltham, Mass.

Vice Admiral John T. Hayward: Presented with the Capt. Robert Dexter Conrad Award, given for outstanding achievement by a civilian or military scientist in research and development for the Navy.

Melvin B. Kline: Promoted to the position of vice president-research and development of American Avionics, Inc., West Los Angeles, Calif.

Harry C. Parker: Joins Scope Incorporated, Falls Church, Va., as production manager.

Jack A. Adams: Will occupy the position of manager of the Huntsville District office of Giannini Controls Corp., Huntsville, Ala.

James D. Hodgson: Named as corporate industrial relations director of Lockheed Aircraft Corp., Burbank, Calif. Succeeding him as director of industrial relations for the Lockheed-California Co. is **Harry B. Winston.**

Charles H. A. Cochran: Appointed manager of Navy systems in the Washington, D. C., Liaison Office of Litton Systems. He was formerly assistant manager.

Don Widener: Formerly with the Norden division of United Aircraft Corp., is now public relations director for Rocket Power, Inc., Mesa, Ariz.

Joseph D. Ryan: Became affiliated with Babcock Electronics Corp. as executive assistant to the chairman of the board.

Asa B. Carmichael and **Peter O. Crisp:** Elected to the board of directors of National Astro Laboratories, Inc., Pasadena, Calif.

Robert L. Jannen: Former director of marketing and assistant vice president, has been promoted to vice president in charge of sales in the Leach Corporation, Compton, Calif.

Dr. A. M. Ball: Will occupy the post of manager of quality assurance in the Chemical Propulsion division of Hercules Powder Company's Explosive Department, Wilmington, Del.

Robert H. Brown: Vice president of Tenney Engineering, Inc., made executive vice president of the Union, N.J., company.

New Product of the Week:

Mobile Flushing Unit

PROBLEMS PRESENTED by in-place cleaning of missile and space booster systems reportedly have been solved by Wyle Laboratories with the development of a mobile flushing unit. Designed to be used with most cleaning solutions, including Freon TF, to clean ICBM propellant loading, propellant transfer, hydraulic and pneumatic systems, two of the units and a mobile drying unit are currently operating at an *Atlas* ICBM launch site, Vandenburg AFB.

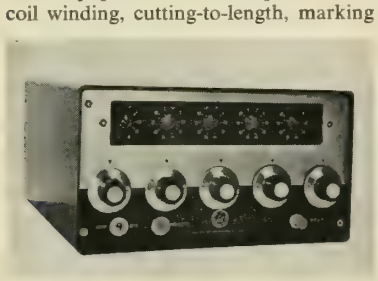
Each consists of a flat-bed trailer 22 ft. long and 8 ft. wide, mounting two tanks totaling 1700 gallons and two pumping systems capable of delivering respectively, 600 gpm and 200 gpm at 50 psi, through separate manifolds and 10 micron-40 micron absolute filters. The two pumping systems can be used simultaneously. All operating controls are mounted at a central control panel and lights are provided for night operation.

Circle No. 225 on Subscriber Service Card

Preset Counters

A series of high-speed transistorized Preset Counters has been developed by Micro Measurements Corp.

The Series 2300 are used with a wide range of sensing devices—photoelectric and magnetic rotation transducers, silicon solar sensors, reed contacts, etc.—for counting, measuring, and monitoring. When preset count is reached, the units automatically actuate other equipment for such operations as coil winding, cutting-to-length, marking wires, locating centers, fault control, and dividing by a preset quantity. Dual preset is also available for sequence control.



Circle No. 226 on Subscriber Service Card

Interferometer flats

Improved interferometer flats, tested to surface figures of 1/200th wave of visible light or better including dielectric coating, are available from the Perkin-Elmer Corp. The flats, fabricated from optical-quality quartz, designed for use in gas phase optical masers, may also be used in etalon and other types of interferometers.

Circle No. 227 on Subscriber Service Card

Counting Strip

A plug-in-type electronic counting strip for a wide variety of counting and timing applications is available from The Victoreen Instrument Co. The model 101 features a modular design concept and is fully transistorized. It displays, by means of illuminated neon lamps or a Nixie tube, the total number of electrical impulses fed into its input. The unit is available as a 1-2-4-8 decade counter with Nixie readout, a 10 neon lamp decade readout, or four neon lamp BCD readout. Several of the counting strips can be connected in series to increase counting capacity, thus making a scaler that is useful with a multichannel analyzer, frequency divider or digital meter.

Circle No. 228 on Subscriber Service Card

Power Supplies

Arnold Magnetics Corp., is producing a line of single-phase, d-c to sine wave power suplies with standard current ratings of 50, 100, 150, 200 and 300 watts. Circuitry is all solid-state.

Standard output voltage is 115 VRMS at 400 cps. The units are hermetically sealed and fully potted, to meet requirements of MIL-E-5272C, including heat, moisture and vibration.

Circle No. 229 on Subscriber Service Card

Transistor Cooler

Inland Electronics announces the development of a transistor cooler. One size will fit all T.O. size transistors. Designed for printed circuit board mounting, the 4 square inches of cooling area not only provides greater cooling efficiency, but also serves as a transistor retaining device.

Circle No. 230 on Subscriber Service Card

Epoxy Molding Compounds

A series of Randac epoxy molding compounds for encapsulating electrical and electronic components by transfer or compression molding methods has been introduced by Mitchell-Rand Mfg. Co.

Designed for encapsulating at high rates of production and reduced labor

costs, the new compounds are granular, one-component systems offering excellent encapsulated appearance with accurate overall dimensions. The compounds exhibit long room-temperature shelf life, good properties of Class F Temperatures, and low moisture absorption.

Circle No. 231 on Subscriber Service Card

Displacement Transmitters

A line of angular and linear displacement transmitters with high output has been introduced by Dynamic Measurements Co. The units convert position or displacement into a proportional electrical voltage for operating indicators, recorders, or controls. Output is sufficiently high to drive recording galvanometers directly, without amplification.

Because they operate on the differential transformer principle, the transmitters provide stepless resolution and a full-span output voltage. They may be used as multiturn potentiometers where wiper contact cannot be tolerated and where constant output impedance is required.

Circle No. 232 on Subscriber Service Card

IF Amplifiers

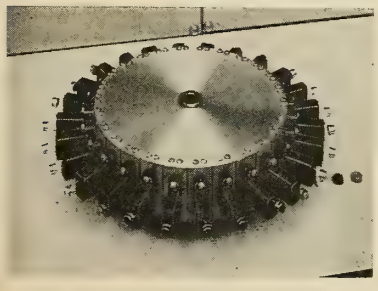
Low-noise, high-gain, and ultra-stable performance—coupled with a ruggedized chassis—are features of the E30 IF Amplifier series available from RHG Electronics Laboratory, Inc. Standard models are centered at 30 and 60 mc, with bandwidths to 10 mc, and gains to 110 db. Custom flexibility provides special designs from 10 to 100 mc, and units meeting MIL-E-16400D are available in all models.

Circle No. 233 on Subscriber Service Card

Transistor Testing Turret

A turret advance unit to transport transistors under test from the operator loading position to the test point, and then to the ejection staion, has been introduced by Optimized Devices, Inc. The turret automatically sorts transistors by dropping them into good and reject bins.

The turret is a removable assembly containing 25 transistor sockets. Connection is made by a rhodium-plated printed circuit board. Any turret can be removed for storage or for environmental testing. The turret also can be connected for lot testing.



Circle No. 234 on Subscriber Service Card

Carbon Potentiometer

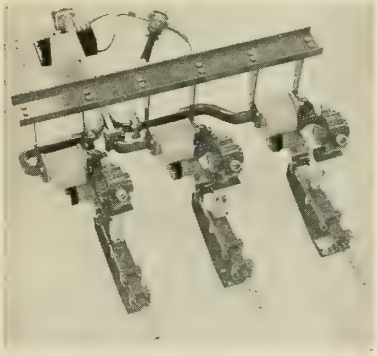
The Trimpot® Div. of Bourns, Inc. has available the Model 3368, a subminiature single-turn rotary potentiometer designed for use in printed circuits and other modular-type applications where extreme angular resolution is not required.

This unit meets steady-state humidity and features an outstanding temperature coefficient over a −65°C to +105°C operating temperature range. Encased in a lightweight, all-plastic case, it is available with panel mount bushing and solder lug terminals.

Circle No. 235 on Subscriber Service Card

Parametric Amplifier

Varian Associates is marketing a V-8353A Phase Stable Parametric Amplifier, a three-channel, non-degenerate, low-noise unit designed and packaged as a pre-amplifier for improving the performance of the AN/FPS-16 radar. The package includes all accessory



equipment and components making possible the significant reduction of the noise figure, from 10.5 to 3.5 db. Specifications: Noise Figure, 3.5db; Bandwidth, 25 mc; Gain, 17 db; Frequency Range, 5.42 to 5.85 Gc., tunable.

Circle No. 236 on Subscriber Service Card

Decade Counting Units

A line of transistorized decade counting units covering ranges from dc to 35 mc are available from Computer Measurements Co. Five basic plug-in units cover ranges from dc to 300 Kc, 2 mc, 12 mc, 20 mc, and 35 mc. Requiring 3¾-in. of panel space, these can be provided with either vertical numeral display or the Nixie readout. They can also be obtained without readout for use as decade dividers.

Circle No. 237 on Subscriber Service Card

new literature

SILICON DIODES—A catalog describing a line of Silicon Double Diffused Alloy Diodes for use in core driving, clamping, gating and similar circuits in high-speed digital computers, has been announced by National Transistor Mfg., Inc.

The diodes described are manufactured by a proprietary method which combines the best features of the diffusion process with those of the alloy technique to provide units which have both extremely high conductance and very fast switching times. Conductances of the order of 500 ma. at 1.0 volt and switching speeds of 500 ma. at 15 millimicroseconds are typical of the diodes listed. In addition, these diodes will withstand 60,000-g centrifuge for 3 minutes peak acceleration and 150 lbs./sq. in. for 30 min. in an aqueous solution. They are encased in a one-piece subminiature glass envelope.

Circle No. 200 on Subscriber Service Card

ELECTRONIC INSTRUMENTS HANDBOOK—Forster/Hoover Electronics, Inc. has announced publication of a 12-page, fully illustrated Electronic Instruments Handbook. Contained in the new booklet is complete data on instruments and systems for detecting discontinuities in metallic materials. Another area covered is that of Magnetic Field Measurement Instruments, vital for precision magnetic field measurement and to provide control mechanisms for magnetic field compensation.

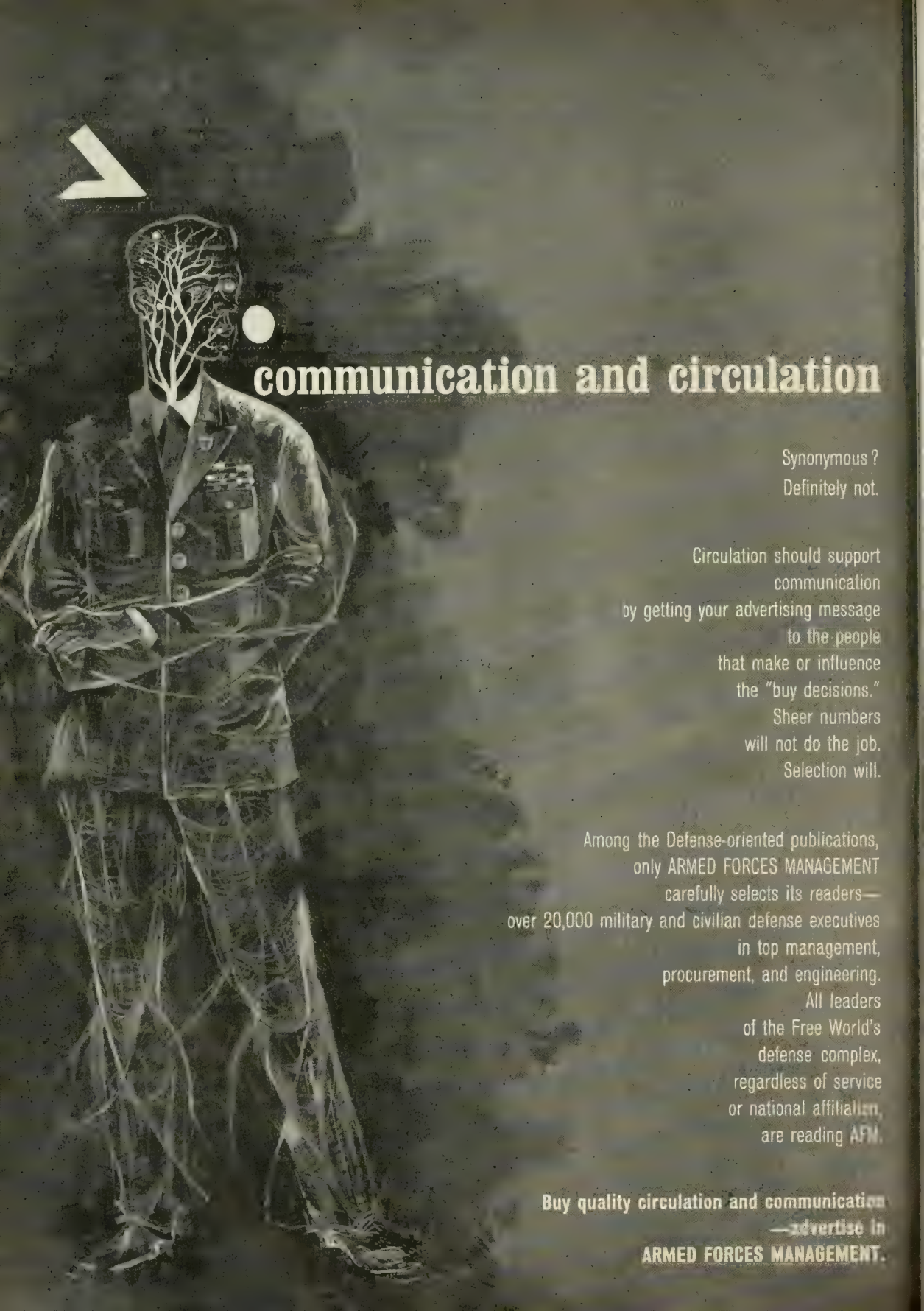
Circle No. 201 on Subscriber Service Card

2500 PSI HYDRAULIC PUMPS—Extra-heavy-duty pumps and motors, for generating fluid power delivered at constant output level, are described in a four-page bulletin from Commercial Shearing and Stamping Co. The units are intended for use in prime moving equipment designed for materials handling, aerospace ground support equipment, and test facilities. New design innovations enabling high operating efficiency are detailed, and performance data are listed. Dimensional data are included for customer design of mounting pads.

Circle No. 202 on Subscriber Service Card

DIODE BROCHURE—Sperry Semiconductor, division of Sperry Rand, has a six-page brochure showing types of subminiature alloy junction silicon diodes. These diodes are designed for general use and for both low- and high-current computer applications. Bulletin SS-200 charts electrical characteristics, shows recovery time patterns and lists the features.

Circle No. 203 on Subscriber Service Card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APRIL

Launch Vehicles: Structures and Materials Conference, sponsored by the American Rocket Society, Ramada Inn, Phoenix, Ariz., April 3-5.

Second Symposium on the Plasma Sheath, sponsored by Electromagnetic Radiation Laboratory, Electronics Research Directorate, L. G. Hanscom Field, Mass., April 3-5.

Nineteenth Annual Conference, Society of the Plastics Industry Western Section, Hotel Del Coronado, Coronado, Calif., April 4-5.

American Society for Quality Control Workshop—Seminar on Management of Quality Control, Hollywood Roosevelt Hotel, Los Angeles, April 4-6.

American Institute of Electrical Engineers South Central Meeting, Hotel Peabody, Memphis, April 4-6.

Thirteenth Annual Advanced Statistical Quality Control Institute, Univ. of Connecticut, Storrs, April 8-20.

American Institute of Electrical Engineers, Rubber and Plastic Industries Conference, Sheraton Hotel, Akron, April 9-10.

Instrument Society of America, National Chemical and Petroleum Instrumentation Symposium, Wilmington, Del., April 9-10.

Thirty-third Annual Scientific Meeting of Aerospace Medical Association, Chalfonte-Haddon Hall, Atlantic City, N. J., April 9-12.

American Society of Mechanical Engineers, Metals Engineering Conference, Sheraton-Cleveland Hotel, Cleveland, April 9-13.

Spring National Convention, Society of Nondestructive Testing, Pick-Carter Hotel, Cleveland, April 9-13.

Southwest Conference and Electronics Show, sponsored by IRE, Rice Hotel, Houston, April 11-13.

Regional Technical Conference, Society of Plastics Engineers, University of Rochester, N. Y., April 12.

Conference on Refractory Metals, American Institute of Mining, Metallurgical, and Petroleum Engineers, Morrison Hotel, Chicago, April 12-13.

American Physical Society, Plasma Physics Symposium, Hilton Inn, Tarrytown, N. Y., April 13-14.

Second Conference on Kinetics, Equilibria, and Performance of High Temperature Systems, Western States Section of the Combustion Institute, University of California, Los Angeles, April 14-16.

Aerospace Systems Reliability Conference, sponsored by the Institute of the Aerospace Sciences, Salt Lake City, April. 16-18.

Symposium on Interactions between Mathematical Research and High Speed Computing, sponsored by the American Mathematical Society and the Association of Computing Machinery, Chalfonte-Haddon Hall Hotel, Atlantic City, April 16-18.

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The 50-Megaton Miracle

LATE LAST YEAR, we wrote an editorial inveighing against the overabundance of booze, blondes and bashes at the shows and exhibits forced annually upon industry.

Perhaps it was the intriguing headline, but the result was an enthusiastic response in our letters column. Readers expressed unanimous approval of our suggestion that all the party-going be dispensed with in favor of fewer meetings with increased emphasis on scientific and technical benefits.

One of our good friends wrote then:

"I would like to think that your editorial will stop or at least slow the onward rush of industrial exhibition, but I am afraid nothing short of the 50-megaton force can accomplish the miracle."

No one is more impressed with the power of the printed word than we are, but what followed amazed even us. The editorial was widely quoted and reprinted. Other magazines picked up the editorial refrain.

There also was a certain amount of friendly and sarcastic comment. Notes from friends we haven't seen in years accused us of hypocrisy. Our beloved employer suggested the alliterative headline perhaps was more autobiographical than imaginative.

Then, from the Aerospace Industries Association meeting in Arizona came a resolution urging member firms to cut down on costly exhibits, to screen attendance of employees at technical meetings and to improve the standard of papers printed.

This issue contains preliminary results of a recent AIA poll of its members on planned participation in trade shows and exhibits this year. The survey shows an overwhelming trend against exhibiting at these shows.

We do not suggest for a minute that we are solely responsible for this. We expressed the sentiments of many in the industry. Mr. Phil Klass of *Aviation Week*, a weekly aviation magazine, has campaigned in behalf of this for some time. Following our editorial, his magazine backed his stand editorially.

The actions of Congress and the Department of Defense in eliminating exhibits as a cost-allowable item were a major factor in the trend.

In addition to non-participation in exhibits, many manufacturers are cutting travel allowances to the rash of meetings, shows and exhibits. Company suites at the recent National Rocket Club meeting were largely replaced by a NRC-sponsored post-dinner reception for head-table guests.

Merger plans of the Institute of Aerospace Sciences and the American Rocket Society, and of the Institute of Radio Engineers and the American Institute of Electrical Engineers, offer further hope of cutting down the number of meetings in the missile/space industry.

THE TIDE HAS TURNED. Much remains to be done but one thing is evident. Somehow, the 50-megaton miracle has been accomplished.

It is a compliment to the maturity of the industry that it has succeeded in reversing this unhealthy trend.

Particularly worthy of note in the AIA survey is the lack of support for the Air Force Association meeting in Las Vegas. If the AFA is serious in its intent of building support for a strong Air Force, a worse site could not have been chosen for this meeting.

We are well aware of the proximity of Nellis Air Force Base and the gunnery ranges to the meeting site. But the nation's taxpayers are far more aware of the proximity of gambling tables and the brightly-lit Strip, with its neon signs and scantily-clad girls.

The long ranks of company and Air Force planes, used to fly general officers and others to the meeting at the taxpayer's expense, will do little to convince the taxpayer his money is being well spent.

We do not want to leave the impression that we are anti-AFA. We are not. There have been charges in the past that pressure was exerted by AFA on industry firms to participate in the AFA meeting or to advertise in *Air Force* magazine. Never have we seen any evidence of this. But the implication of possible pressure has been there, and it is a healthy sign to see the industry resist it when the circumstances are as unfavorable as they are this year.

Despite some excessive enthusiasm and some enthusiastic excesses, AFA provides a valuable forum of support for the Air Force. But Las Vegas is more reminiscent of Roman orgies than Roman forums.

We are pleased to see that a majority of the industry firms polled are declining to lend their support to this ill-advised exhibit, which can do little to build up the image of either the Air Force or the industry.

William J. Coughlin

MOBILIZING FOR THE MOON

About fifty-billion dollars will be spent in the next decade to develop the moon program—80% with industry.

NOVEMBER 27, 1961 — MISSILES AND ROCKETS published its NASA Issue, an in-depth study of the National Aeronautics and Space Administration's programs, projects, facilities, personnel, and contracting procedures—emphasis centered on NASA's future material and contract requirements. JANUARY 5, 1962 — Over 1,000 single copies ordered by companies and individuals. JANUARY 11, 1962 —NASA purchased 60,000 reprints of the editorial section of the NASA issue.

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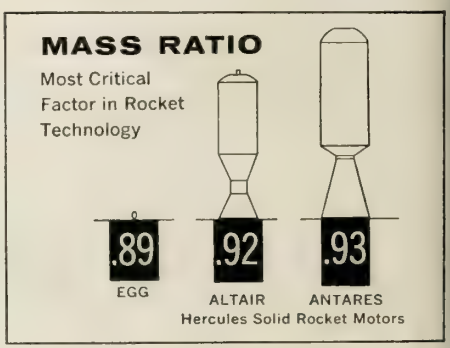

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THE WEEKLY OF SPACE SYSTEMS ENGINEERING

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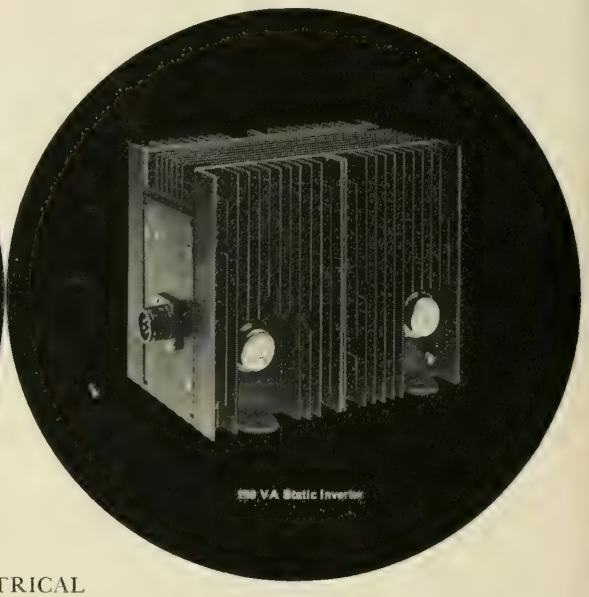

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THE WEEKLY OF SPACE SYSTEMS ENGINEERING

missiles and rockets

Volume 10, Number 15 April 9, 1962

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THE COVER

First photo of preliminary full-scale model of NASA's three-man Apollo spacecraft, built by prime contractor, North American. Inside 13-ft. wide, 12-ft.-high craft, one crewman sleeps while others pilot and navigate.

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letters

Immersion's Value

To the Editor:

This is a reply to the letter from Mr. C. W. Lear, of Space Technology Laboratories, in M/R, Jan. 8, regarding weightlessness tests.

Here in the Psychophysiological Stress Section of the Biophysics Branch of the 6570th Aerospace Medical Research Laboratories, we are using complete water immersion to simulate some aspects of weightlessness. Mr. Lear is quite correct when he says that no matter how the body is supported, by water or balloons, it remains in a g field and balance organs (particularly the otoliths) are affected. However, he is equally incorrect when he states that "true weightlessness is accomplished by relieving the inside of the body of all pressure gradients." As we are sure Mr. Lear is aware, all vital functions are dependent on pressure gradients —whether osmotic, hydrostatic, electrical or ionic. That all pressure gradients are not relieved during weightlessness is documented by all the available data from the study of animals in orbit, including the flights of Gagarin and Titov.

Water immersion is indeed water immersion and not weightlessness, and the subject is in a one-g field. However, in at least two aspects we feel that water immersion simulates situations that all authorities agree will be experienced during true weightlessness: decreased demands for musculoskeletal support, and diminished or absent hydrostatic pressure effects of blood. Because of decreased demands for musculoskeletal support to counteract gravity, water immersion produces deconditioning effects on the cardiovascular system, muscle, bone, etc., similar to long-term bed rest but much accelerated. In the absence of hydrostatic pressure due to gravity, cardiovascular reflexes become less efficient. The more we know about these phenomena, their mechanisms and possible protective techniques, the better prepared we will be to predict, explain and prevent the biologic effects of true weightlessness that will be experienced during orbital and space flight . . .

Water immersion is not weightlessness, but it is a vital tool in the study of phenomena that must, for the present, be studied by analogy.

Michael McCally, Capt., USAF, MC
Psychophysiological Stress Section
Biophysics Branch
Biomedical Laboratory
6570th Aerospace Medical
Research Laboratories
Wright-Patterson AFB, Ohio

A for Aerospace

To the Editor:

Your March 19 cover story, on Robert R. Gilruth receiving the 1962 Goddard Memorial Trophy, contained an unfortunate error.

The initials IAS did originally stand for the Institute of the Aeronautical Sciences, as stated in the third column, second line of your story. But since Oct. 27, 1960, our name has been the Institute of the AEROSPACE Sciences.

Mr. Gilruth, by the way, is not only an IAS Fellow and 1950 Reed Award winner. In January of this year he received the coveted Louis W. Hill Space Transportation Award, which carries a $5000 honorarium, the largest such honorarium available through any scientific society.

Paul V. Spillar
Public Relations Manager
Institute of the Aerospace Sciences
New York

At the time the Institute awarded the Sylvanus Albert Reed Award to Mr. Gilruth in 1950, IAS still was the Institute of the Aeronautical Sciences. For that reason, we used the Aeronautical reference in connection with the award. For a discussion of IAS as the Institute of the Aerospace Sciences, see M/R, March 12, pp. 38 and 46.—Ed.

Soviet Hydrofoil Lead

To the Editor:

Your ASW Engineering article in the March 5 issue ("Russia Speeds Up Hydrofoil Production," p. 42) was most timely and intriguing. The Russians are so far ahead in hydrofoil experience that our present efforts appear almost ridiculous as well as academic.

Information we have gathered from various sources indicates that Russia has about 60 Raketas (66-passenger) in operation with about 200 in process, two to three Meteors (150-passenger) in operation with 85 in process, plus one Sputnik (300-passenger) and one Mir (90-passenger) in operation . . .

The funding of the U.S. Navy programs mentioned in the article—less the HS Denison, which is a Department of Commerce and industry project—has not been much more than the Army funding of a small drone aircraft surveillance system which was recently cancelled. In view of the following, this seems inexplicable.

In 1953, the sea trials of the Albacore were completed and the value of clean underwater shapes finally recognized. In January, 1955, the Nautilus finished her sea trials, proving the practicability of nuclear propulsion and high-yield compact power packages. Thus, since 1955 there *has* been evidence that this country has had a pressing need for fast water transportation if it ever intended to contain the nuclear-powered submarine . . .

The background of history should have brought this whole subject into sharp focus. In "The Battle of the Atlantic," naval historian Adm. S. E. Morison wrote, "In terms of money, counting sunken ships and cargoes, time lost at sea and expense of operating naval vessels and planes to protect the seaways, the efforts of the American Republics and the British Empire amounted to some HUNDREDS OF BIL-

LIONS OF DOLLARS (caps mine)." Compare this with estimated property damages in the bombing of Britain of $5 billion, and in the bombing of Germany less than $50 billion. Consider that a relatively small number of men—about 39,000—manning boats which were three to four times smaller than present Russian submarines managed to sink some 2800 ships. At one time the Allied tanker fleet was disappearing at the rate of 3½% per month, according to General Marshall . . .

Our timid approach to hydrofoils may well prove fateful. The idea that we must design the 1980 hydrofoils in 1962 is certainly not consistent with the history of ANY human development.

Richard L. Barkley
President
Aquanautics, Inc.
Palo Alto, Calif.

'High Flight'

To the Editor:

I would like to commend you for the poetic editorial in your Feb. 26 issue.

J. P. Davis
Nuclear Engineer
Burns and Roe, Inc.
New York

To the Editor:

In a week that saw the Glenn flight covered from all possible editorial angles by all media, I think your handling of the subject stands well above the rest in eloquence and dignity.

Jack Page
Grant Advertising, Inc.
Hollywood, Calif.

To the Editor:

I was very much moved to see the poem "High Flight" as your *fitting* editorial about John Glenn's orbital flight . . .

May I mention, as an afterthought, that "High Flight" originated in World War II, and is considered one of the best poems to have come from this holocaust. John G. Magee was a member of the RCAF, killed in action.

His wonderful poem inspired me so much that as early as 1945 I translated it into German. My free translation was published in several German newspapers.

Dr. Hugo Gabriel
Redondo Beach, Calif.

To the Editor:

I would appreciate it if you could tell me where I might get a copy of "High Flight."

Frances R. Canning
Lockheed Missiles & Space Co.
San Jose, Calif.

In response to reader demand, M/R still has available reprints of the Feb. 26 editorial page in color, without the editorial slugline or magazine identification, on heavy paper suitable for framing, at 50¢ each. There are still a few similar laminated hard-finish plaques, mounted on beaverboard, available at $2.25 each. Orders should be addressed to: Marketing Department, Missiles and Rockets, 1001 Vermont Ave., N.W., Washington 5, D.C. Payment must accompany order.

Increased technical responsibilities in the field of range measurements have required the creation of new positions at the Lincoln Laboratory. We invite inquiries from senior members of the scientific community interested in participating with us in solving problems of the greatest urgency in the defense of the nation.

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The Countdown

WASHINGTON

NASA to Procure Apollo Solid Booster

NASA's Manned Spacecraft Center will procure a new solid booster for launching of boilerplate *Apollo* spacecraft on earth-orbital flights next year. The booster will be a cluster of three to seven solid rockets, possibly with a *Scout* first stage. Proposal conference is imminent for the contract, which will be worth about $10 million.

Award of RIFT Contract Due

Award of the prime contract for *RIFT* (Reactor In Flight Test) can be expected during the last week in April or the first week in May, according to NASA officials. Competing firms: Martin Co., Lockheed Missiles and Space Co. and General Dynamics/Astronautics.

Congress to Cut NASA Budget

Two major NASA programs are almost certain to be cut by Congress. A House space subcommittee already has voted to kill the $10-million request for the *Prospector* program. An influential member of the space committee says some $70 to $80 million also should be cut from the Manned Space Flight Program. Prime target for this will be *Nova,* with committee members predicting a cut of 25 to 30% in the $163 million requested.

More Land for Cape Canaveral

Watch for an announcement soon that an additional 10,000 acres of land will be purchased to expand Cape Canaveral. Decision as to whether NASA or Department of Defense will fund the purchase currently is holding up the announcement. The new land will be north of the recent NASA moon base expansion.

That Question of Overflights

NASA and DOD are nearing agreement on location of the *Titan III* pads at Cape Canaveral. The pads will be within NASA's new land acquisition between the *Advanced Saturn* and *Nova* pads. Both NASA and the Air Force recently testified behind closed congressional doors that overflights may be necessary in certain cases. Reports that AF had opposed this were incorrect (M/R, April 2, p. 12). But both agencies pointed out that, in the past, complete evacuation was required before an overflight.

J-2 Engine Gets Nod for Saturn

NASA officials have decided a single J-2 engine will become the second stage of the *Saturn C-1* vehicle. It will replace the current six A-3 engine stage. Change will take place in the 1964-65 time period. The single J-2 stage thus can be test-flown for future use in the *Nova* and *Advanced Saturn* launch vehicles.

Announcement of 120-inch Winner Near

Contract competition for the 120-inch. solid booster for *Titan III* is coming down to the wire with United Technology Corp. as the favorite in Washington betting. Lockheed Propulsion Co. is second, with a good Pentagon source warning: don't count Aerojet-General out yet. Take your pick. Contract should be announced by week's end.

That Mixed-Up MRBM Program

Latest word on the muddled MRBM missile program is that the RFQ will go out by April 15 for six-month study contracts, with dual contracts to be awarded on subsystems. One reason for the delaying maneuver on a missile already studied thoroughly: NATO may not want it.

Polaris A-4 Under Navy Study

Navy officials say they still are studying the need for an A-4 *Polaris* which would further extend the standoff capability of *Polaris* submarines. They point out that the system is flexible enough to accommodate missiles of larger size which can take advantage of new developments in propulsion and guidance. Range of the *A-3:* 2500 n. mi.

AF Funding Revealed for Titan Buyout

Air Force officials reveal that $416.6 million will be spent on procurement of *Titan* ICBM's during FY '63. Fiscal '64 funding will call for $106.8 million to complete equipping of *Titan* squadrons. In FY '65, $68 million will be asked for procurement of missiles for crew training launches.

SUBROC Slippage Hit by Congress

Congressmen raked the Navy over the coals during procurement hearings on the Goodyear *SUBROC* underwater-to-underwater missile. According to one Congressman, the program has slipped at least three years. Fidgeting Navy officials, exonerating Goodyear, blamed AiResearch for slippage in developing the internal power unit.

INDUSTRY

Germans Buying Tartar For Ships

West Germany plans a ship-building program to back up acquisition of General Dynamics/Pomona Tartar missiles. Other nations buying the system include: Italy, France, Australia and possibly Japan.

Lockheed 120-inch Firing Set

Firing of Lockheed's 120-inch booster is set for the first week of May at the propulsion company's Portero, Calif., facility. Firing time: 120 sec.

UTC Options Florida Land

United Technology Corp. has taken an option on land at West Palm Beach, Fla., not far from the Pratt & Whitney facility. Plans call for its use as a big booster plant.

INTERNATIONAL

Norway to Make Bullpup

Norway will be the prime European contractor for the Martin *Bullpup.* Some parts will be manufactured in other NATO countries. Britain, whose order for *Bullpups* will be double that of any other European nation, had been a contender for the $7-million contract but bowed out in favor of Norway.

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The Missile/Space Week

No Extra Solid Funds Seen; Liquids Officially Lagging

Congress apparently has decided not to increase the Kennedy Administration budget request for solid propulsion development — although NASA officials admit their liquid propulsion program is behind schedule.

MISSILES & ROCKETS has learned that a House space subcommittee has dropped plans to boost NASA's budget in the solid motor area by $35 or $40 million.

At the same time, Congress is nearing completion of its consideration of the Air Force budget, with no sign that increased funds for solids are in the works.

There is one ray of hope for solid propulsion backers. Thomas F. Dixon, NASA deputy associate administrator, told the subcommittee that if technological development warrants it, NASA will request a supplemental budget authorization for solids later this year.

The subcommittee members, led by Chairman Victor Anfuso (D-N.Y.), came away from a meeting with Dixon firmly convinced that the U.S. has parallel development programs in liquid and solid propulsion.

Anfuso said that if NASA and the AF continue to cooperate on solid motor development, "I am satisfied."

He also disclosed the following budget figures for AF development in Fiscal '63: 156-in. motor, $20 million; 240-in. motor, $20 million; 120-in. motor for the *Titan III*, $73.3 million; facilities, $15 million.

Meanwhile, a top NASA official admitted that development of liquid-propulsion engines is behind schedule.

A. O. Tishler, assistant director of propulsion for advanced manned spaceflight, told M/R that "we're late across the board."

Tishler blamed contracting procedures which enable contractors to set target dates which are impossible to meet.

He declared that slippage in the liquid program is currently a matter of a few months. And he contended that the engine delays will not affect NASA's launch vehicle schedules.

"Some people would like to believe we're in trouble, but it is not true," Tishler said.

He said, however, that the Preliminary Flight Rating Test of the F-1 engine will not take place until mid-summer of next year. The PFRT for the engine—which will power the first stages of the *Advanced Saturn* and *Nova*—was scheduled for March, 1963.

He said an additional two years will be required before the engine will be ready to be test-flown in a vehicle.

This would defer the first launch of the *Advanced Saturn* until mid-1965 at the earliest, leaving little time to get the big booster ready for its 1966 circumlunar missions with the *Apollo* spacecraft.

Tishler said development of the J-2 liquid hydrogen-liquid oxygen engine is also behind schedule. The first test firing of the engine was accomplished recently, but it did not reach full thrust.

The NASA official praised Pratt & Whitney for its work on the *Centaur* engine.

"The A-3 is a pretty good engine and will be used for a long time. They have reason to be proud of it," Tishler said.

The first launch of *Centaur* was scheduled for late last week. The vehicle is one year behind its planned development program. Technical or weather difficulties could force further delay in the first launch.

Committee Okays NASA Boost

The House Appropriations Committee approved $80 million in Supplemental Fiscal '62 budget funds for NASA, but turned down the space agency's request for $71 million in construction funds.

The committee said it was not opposed to the construction item, but that it could not give its approval until it was authorized by the Space Committee.

The authorization is expected before the end of the current session of Congress.

The approved research and development funds represent a $5-million reduction in the NASA request.

NASA told the committee that $50 million was slated for the *Advanced Saturn* program, $9 million for *Centaur*, and $26 million for a start on the M-1 engine.

Shots of the Week

The Army's *Nike-Zeus* antimissile missile successfully intercepted a *Nike-Hercules* high above White Sands Missile Range, N.M., March 28.

The second successful intercept of a *Hercules* in four months, the

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Zeus test was designed as a comprehensive evaluation of major components of the system against a high-performance missile target.

Neither missile contained a live warhead, and the intercept was determined by electronic measurements.

Elsewhere:

• A *Polaris A-2* missile was destroyed about 10 seconds after launch from Canaveral March 30.

The 1700-mile solid-fueled missile was destroyed by the range safety officer after it veered sharply back to the north. Although flaming wreckage from the missile fell on the Cape, officials said there were no injuries or property damage.

A four-stage *Scout* rocket was launched from Wallops Island March 28, carrying a 90-lb. payload designed to probe 4000 miles into space and transmit back information about the ionosphere.

Measurements included electron-density profile, ion density and type of ions in the ionosphere.

• France fired six missiles in a successful series of test shots in the Sahara March 19-26, according to a Defense Ministry announcement.

Two of the six tests involved the *Agate* missile—the basic vehicle for development of a future French missile striking force and space booster.

U.S.-Soviet Space Talks End

U.S. representative Dr. Hugh L. Dryden, of NASA, and Soviet delegate Anatoli A. Blagonravov on March 30 ended four days of talks on possible areas of cooperation in the exploration of space.

In a terse statement by Dr. Dryden, it was revealed that representatives of the two countries would meet again for expanded talks, either in Washington between April 30 and May 10 or in Geneva on May 28.

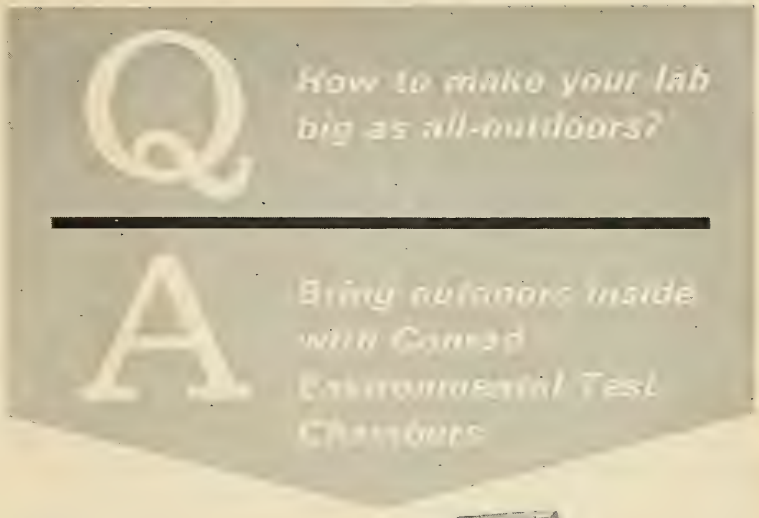
LeMay Warns of Space Threat

Air Force Chief of Staff Gen. Curtis E. LeMay, in a speech at Assumption College in Worcester, Mass., spoke out forcefully for the development of military space systems "as quickly as possible."

In a highly restrained, literate speech, LeMay carefully developed the theme that the U.S. has traditionally been slow to recognize the military benefits of scientific advances.

We cannot afford to repeat this mistake in space, the AF chief said, in arguing for an expanded military space role.

(See editorial, p. 46)



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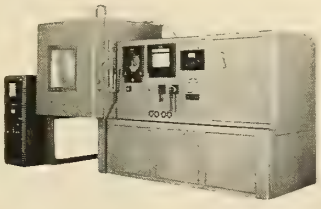

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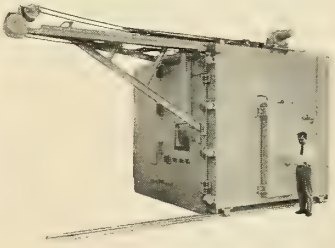

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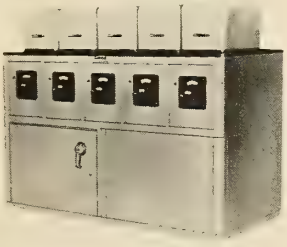

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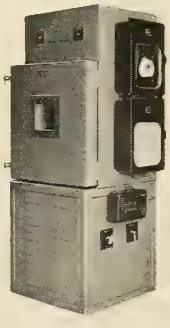

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Spacecraft Due for $1.2 Billion

Request for manned programs jumps eight times— to $863.6 million; $273.5 sought for unmanned systems

NASA WILL POUR over $1.2 billion into development of manned and unmanned spacecraft as the U.S. drive to land a man on the moon accelerates sharply in Fiscal '63.

This is by far the largest single item in the $2.9-billion research, development and operations budget which NASA is presenting to Congress.

Requested funds for manned spacecraft programs increased by almost 800%—jumping from $147.2 million in Fiscal '62 to $863.6 million in the upcoming fiscal period.

Almost half a billion dollars will be spent on the command, service, and lunar-landing modules of the *Apollo* spacecraft—the vehicle designed to land three men on the moon by 1967-68.

Design, fabrication and production of the two-man *Gemini* spacecraft will cost approximately $102 million. The first of the spacecraft will be test-flown in the middle of next year.

NASA has also asked Congress to approve a $273.5-million budget in the unmanned spacecraft area—$151.8 million for lunar vehicles and $89.7 million for craft which will explore the planets.

Major items in the lunar exploration area include the *Ranger* spacecraft, $44 million; *Surveyor,* $97.3 million and *Prospector,* $10.4 million (although *Prospector* is in trouble on Capitol Hill. See p. 9).

Interplanetary spacecraft programs call for $9.2 million for *Mariner R;* $73.7 million for *Mariner B* and $6.8 million for *Voyager.*

A breakdown of requests for manned and unmanned spacecraft programs follows (in millions of dollars):

• **Project Apollo** — NASA has requested $617 for the manned lunar landing flight program. Funding the command and service modules calls for $345; lunar-landing module, $123.1; guidance and navigation system, $32.4; instrumentation and scientific equipment, $11.5; operational support, $2.5; supporting development, $3; solid rockets for suborbital flights, $8.8; and the *Saturn C-1* launch vehicle for earth-orbital flights, $90.8.

The major effort in Fiscal '63 will be devoted to design of spacecraft modules and components. Boilerplate models of the command module will be flown on early developmental missions of the *Saturn C-1.* Initiation of spacecraft fabrication for the earth-orbital *Apollo* flights will begin before the end of the year. Development of a solid rocket booster for ballistic flights will be initiated.

Other major problems which will receive concentrated efforts in Fiscal '63:

—An off-the-pad and post-launch abort system must be designed for the command module. It is likely that an escape tower similar to that on the *Mercury* capsule will be used for emergencies at any time during the flight.

—Development of testing of the life support and environmental control requirements for the long (7-to-14-day) *Apollo* missions will begin.

—Development of biomedical monitoring equipment and techniques and systems for the collection, storing, and processing of psycho-physiological data will also be pursued. Studies preliminary to crew selection will be started.

• **Project Gemini**—The total budget request was $203.2 million, including $22.5 million for spacecraft engineering development, $86 million for fabrication and procurement, $2.1 million for flight-test support, $15.2 million for operational support and $5.5 million for supporting development.

Procurement of launch vehicles will approximate $72 million, with $50 million earmarked for *Titan II* and $21.8 million for *Atlas-Agena.*

NASA has scheduled 12 flight missions for the two-man *Gemini* capsule, including eight manned rendezvous missions. Current planning calls for procurement of 12 capsules, 11 *Atlas-Agena* boosters and 15 *Titan II* launch vehicles.

Peak production of the spacecraft will be reached during Fiscal '63; the first qualification flight is planned for mid-1963. Although the spacecraft will be based largely on the *Mercury* capsule technology, new subsystems which will be needed include reaction control, on-board power, in-space maneuvering, and control to meet the demands of increased spacecraft size and extended maneuverable flight.

Operational support services for the flight mission will be provided by organizations other than McDonnell Aircraft Corp., prime contractor for the project. This includes the cost of additional contractor personnel deployed with the tracking net and at the control center, and the cost of necessary ship operations.

Supporting development covers project components and test items that are not generally included in the prime contractor's effort. One example would be the paraglider for the spacecraft landing system.

THE NASA BUDGET

MISSILES AND ROCKETS *this week devotes its leading news pages to a detailed breakdown of the Fiscal 1963 research and development budget of the National Aeronautics and Space Administration*

Where will NASA spend its money in FY '63? These pages will tell you. For your convenience, we have broken down the budget figures into the following sections:

Spacecraft ..... **p. 12**
Satellites ..... **p. 14**
Launch Vehicles ..... **p. 15**
Propulsion ..... **p. 16**
Electronics ..... **p. 17**
Space Power ..... **p. 34**

• **One-day Mercury missions**—NASA has requested $12.1 million for the one-day manned orbital flights with the *Mercury* capsule. Four such flights are planned—the first expected early next year.

The total includes: capsules, equipment and services, $4.5 million; flight operations, $1.4 million and recovery operations, $6.2 million.

Modification of the last four *Mercury* capsules will include the addition of more cooling capacity for equipment such as the inverters and telemetry transmitters, addition of three 3000-watt batteries, and addition of hydrogen peroxide to be used by the attitude control jets and heating equipment to keep the horizon scanner within temperature limits during the longer flights. In order to handle the slightly increased weight of the bigger capsules, posigrade and retrograde rockets more powerful than those used in the current *Mercury* will be procured.

• **Manned spacecraft technology and aerospace medicine**—A total of $31 million has been requested from Congress to fund technological efforts.

Some $11.7 million is asked for manned spacecraft technology, including: mission analysis, $480,000; systems development and analysis, $6.1 million; mission simulation and training, $2.2 million; and operational methods and systems, $2.9 million.

Aerospace medicine funds include provision for development and testing in the following areas: acceleration and weightlessness effects, $6.2 million; radiation protection, $5.4 million; life support systems, $4.7 million; and crew medical selection and monitoring, $2.8 million.

• **Ranger (in millions)** — Project management and support, $.9; systems analysis & integration, $1.6; structural design & development, $1; AMR facilities and administration, $.5; lunar capsule, $1.2; compact TV systems, $5.7; data reduction and processing, $1; operations, $.5; scientific experiments, $1.2; environmental requirements and testing, $.4; experimental analysis, $1.1; communication and telemetry, $2.1; guidance and control, $2.1; power systems and energy control, $.4; pyrotechnics design and development, $.1; instrumentation systems, $.6; computer support, $1.8; and *Atlas-Agena* launch vehicles, $20.9.

• **Surveyor (in millions)** — Project management and support, $.9; systems analysis and integration, $.5; structural design and development, $.2; spacecraft development contract, $29.1; orbiter spacecraft development contract, $18; planning and documentation support, $.2; data reduction and processing, $8.4; scientific experiments, $10.1; environmental testing and requirements, $.3; scientific experiment analysis, $.6; communications and telemetry, $.1; guidance and control, $.3; alternate mission package, $5.1; orbiter surveillance subsystem, $5.4; computer support, $.5; and *Centaur* launch vehicles, $17.3.

• **Prospector**—Spacecraft development contract, $6.8; systems analysis and integration, $2.5; experiment analysis, $.1; project management and support .$8.

• **Mariner R**—Total $9.2 million, including $3 million for the spacecraft and $6.2 million for the *Atlas-Agena* launch vehicles.

• **Mariner B**—Total $73 million, including project management and support, $3.1; systems analysis and integration, $4.9; structural design and development, $4; AMR facilities, $.2; data reduction and processing, $3.6; operations, $.5; scientific experiments, $8.8; environmental requirements and testing, $3.4; communications and telemetry, $7; guidance and control, $10.7; TV systems, $1.7; power systems and energy control, $6.5; instrumentation services and facilities $.8; computer support, $.6; and *Centaur* launch vehicles, $17.1 million.

• **Voyager** — Total, $6.8 million. Project management and support, $.7; systems analysis and integration, $.6; structural design and development, $.6; scientific experiments, $.9; communications and telemetry, $1; guidance and control, $2.2; power systems and energy control, $.6.

• **Lunar advanced research (millions)**—Mapping the lunar surface, $.8; lunar fields and atmospheric studies, $.5; lunar surface and interior studies, $1.8; instrumentation research, $1.7; data analysis and interpretation, $1.2; spacecraft systems and mission research, $.4; and materials and structures research, $.7.

• **Planetary and interplanetary advanced research** — Total $7.8 million, including planetary atmospheric, surface and subsurface studies, $1.1; interplanetary particles and fields, $1; biological studies, $1; materials and structures research, $1; instrumentation research, $260,000; planetary astronomy, $.7; cosmology, $.2; spacecraft systems and mission research, $1.8; and data analysis and interpretation, $.4.

• **Advanced lunar technical development**—Total $6.6 million; design and reliability studies and services, $1.1; data processing systems, $.3; guidance and control systems, $1; communications & electronics systems, $1.3; lunar surface analysis instrumentation, $1.7; development of radiometers & spectrometers, $.6 and materials and structures development $.6.

• **Planetary and interplanetary advanced technical development** — Total $10.4 million, including design and reliability studies, $.9; guidance and control systems, $1.4; communications and electronics systems, $1.2; planetary surface analysis instrumentation, $1.2; bioscience instrumentation, $1; interplanetary probe instrumentation, $.4; materials and structures development, $1; and propulsion systems development, $3. ⌗

Advanced Manned Spacecraft Programs

(in millions)

	FY '62	FY '63
Manned Spacecraft Technology	$ 14.9	$ 11.7
Aerospace Medicine	17.2	19.3
Flight Missions	115.	832.
Total Advanced Manned Space Flight	147.	863.
Mercury	68.2	13.2
Lunar Unmanned Spacecraft Program	106.	151.8
Interplanetary Unmanned Spacecraft Program	44.7	89.7

Spacecraft Technology Flight Programs

Trailblazer Re-entry Project	$ .2	$ .2
Horizon Sensors	.7	.7
Recoverable Micrometeoroid Probe	.2	.1
Re-entry Heating and Materials Experiments	3.3	2.5
Micrometeoroid Satellites	.6	3.5
Engineering Test Flight Experiments	.8	1.9
True Environment Engineering Satellites	....	4.
Flight Re-entry at Hyperbolic Velocities	.9	3.
Total Flight Program	11.9	23.1
Advanced Research and Technology	25.2	30.8
Total Spacecraft Technology	$37.1	$54.

SPECIAL REPORT

NASA R&D BUDGET

Satellite '63 Outlay To Top $311 Million

ComSat request is $85.3 million, meteorological program calls for $51.1 million budget figure

NASA PLANS to spend over $311 million for scientific, meteorological and communication satellites in Fiscal 1963.

Scientific exploration with orbiting satellites is earmarked for $175 million, including $141 million for the flight program, $17.4 million for advanced research and $16.2 million for advanced technological development.

The space agency is requesting $85.3 million for communication satellites, including $2.6 million for advanced research and $2.4 million for advanced technical development.

Major elements in the $80.2-million flight program are Project *Rebound*, $16.7 million; *Relay*, $19.1 million, *Syncom*, $4 million; *Intermediate Altitude Satellite (Advanced Relay)*, $21.5 million and the *Advanced Synchronous Communications Satellite*, $18.6 million.

Relay funds will be used to complete the second series of *Relay* flight models and to partially fund the procurement of three *Thor-Delta* boosters. *Syncom* funding will provide the major share of the cost of three spacecraft. The *Advanced Relay* funds will enable NASA to begin development and fabrication of three spacecraft and procurement of launch vehicles. The *Advanced Syncom* budgetary request covers procurement of two of the three spacecraft which are planned. A start will also be made on purchase of the required *Atlas-Agena* launch vehicles.

Here is the breakdown of the requested ComSat budget (in millions):

—*Rebound*—Total, $16.7; spacecraft, $1.6; satellite flight units, $1.75; systems analysis, coordination and planning, $.8; receivers, antenna feeds and terminal equipment, $.8; communications experiments, $.6; *Atlas-Agena* launch vehicles, $11.8.

—*Relay*—Total, $19.1; spacecraft fabrication and checkout, $6.2; systems coordination and planning, $3.0; special ground equipment, $1.1; operations, $2.3; *Thor-Delta* launch vehicles, $6.6.

—*Syncom*—Total, $4.1; spacecraft, $2.0; Minitrack operational support test, $.3; computer services, $.1; data reduction, $.4; ground station operation, $1.0.

—*Intermediate Altitude Satellite*—Total, $21.5; spacecraft, $6.4; systems coordination and planning, $2.1; radiation experiment, $1.0; *Atlas-Agena* launch vehicles, $10.2.

—*Advanced Syncom*—Total, $18.6; spacecraft, $6.4; ground control and communications equipment, $5.9; *Atlas-Agena* launch vehicles, $6.2.

• **Meteorological**—Budget requests for the meteorological satellite program total $51.1 million, including $1.8 million for advanced research and $9.6 million for advanced technical development.

The $39.7-million flight program calls for the procurement of four *Tiros* and two *Nimbus* satellites. Development of prototype hardware for the *Aeros* satellite will be accelerated.

Budgetary requests in the meteorological satellite flight program include:

—*Tiros (IV to VII)*—Total, $3.3; spacecraft fabrication, assembly, test, $.6; integration, $1.5; data acquisition, $.1; data reduction, processing, and analysis, $.9; infrared subsystem integration, $.2.

—*Nimbus (I and II)*—Total, $17.9; scientific experiments, $.2; integration and testing, $3.0; attitude control, $1.9; solar power supply, $1.2; advanced vidicon systems, $.8; high-resolution infrared detector, $.06; medium-resolution infrared detector, $.4; low-resolution infrared, $.03; command clock, $.06; PCM telemetry, $.7; S-band transmitters, $.03; VHF/FM transmitter, $.03; VHF/AM transmitter, $.02; ground station integration, $.8; launch support, PMR, $.3; video data compression equipment, $.5; data analysis and processing support, $1.7; tape and film, $.2; spacecraft modification and qualification, $1.1; launch vehicle *(Thor-Agena)*, $4.8.

—*Nimbus (III and IV)*—Total, $17.0; scientific experiments, $.2; integration and testing, $1.7; attitude control, $1.8; solar power supply, $.8; advanced vidicon systems, $.7; high-resolution infrared, $.2; medium-resolution infrared, $.4; low resolution infrared, $.1; command clock, $.2; PCM telemetry, $.4; infrared ground equipment-real time, $3.4; infrared data display, $1.0; electrostatic tape camera, $1.1; spectrometer, $.6; launch vehicle *(Thor-Agena)*, $4.4.

—*Meteorological Soundings*—Total, $1.5; fabrication, rocket instrumentation, $.5; grenades, $.1; field services and data reduction, $.2; sound-ranging field services, $.2; overseas support, $.3. ⌘

Fiscal '63 Budget Requests for Scientific Satellites

(APPROXIMATE)
(IN MILLIONS)

Orbiting Geophysical Observatories	$ 58.6	Atmospheric Structure Satellite	$ .6
Orbiting Astronomical Observatories	$ 45.7	International Ionosphere Satellite (U.K. #1)	$ .3
Orbiting Solar Observatory #1	$ .9	International Satellite (U.K. #2)	$ 5.2
Orbiting Solar Observatory #2	$ 2.9	International Satellite (U.K. #3)	$ 1.7
Advanced Orbiting Solar Observatory	$ 11.7	International Satellite (#4)	$ 1.7
Topside Sounders	$ .9	Space Biology	$ 3.6
Ionosphere Monitor	$ 2.9		
Geoprobes	$ 4.4		
Energetic Particles Satellite	$ .3	Total Flight Program	$141.5

For Launch Vehicles: A Record $855.2 Million

NASA ESTIMATES that total development of the *Advanced Saturn* launch vehicle will cost approximately $1 billion. The big down payment, $335.1 million, will be made in Fiscal '63.

Funding for the *Advanced Saturn*—which is now the primary booster for the *Apollo* program—accounts for almost one half of NASA's record $855.2 million launch vehicle budget in the fiscal year beginning June 30.

Other major items include $249.2 million for *Saturn C-1*, $163.5 million for *Nova*, $66.6 million for *Centaur*, $8.9 million for *Scout*, $230,000 for *Delta* and $31.6 million for launch vehicle technology.

Almost all of the *Advanced Saturn* budget will go for development engineering and procurement of flight and expendable hardware.

Hardware procurement for the booster includes $41.1 million for long-lead-time items needed for the test and assembly of the first stage, and $38.6 million for static-test, one dummy flight-test stage, and the first flight-test vehicle of the second stage. Other slated purchases include $9.7 million for the third stage, $12 million for two *Saturn C-1* vehicles which will be used to test-fly the third stage, $3 million for the guidance system and $5.4 million for system integration.

Total budget request for development engineering is $162.9 million, including $68.1 million for the first stage, $59 million, second stage; $15.9 million, third stage; $7.1 million, guidance system, $12.6 million systems integration.

Procurement of engine flight hardware will cost $28 million, including $16.4 million for 10 F-1 engines and $12.4 million for 33 J-2 engines.

The $33.1-million support budget includes $13.6 million for ground support equipment, $5.4 million for system instrumentation, $2 million for launch operations, and $12 million for procurement of propellants.

Other vehicle requests include:

• **Nova** — NASA is requesting a total of $163 million for the giant booster, but opposition is building up in Congress and it is very likely that this will be slashed, perhaps by as much as $50 million.

The total request includes $131.9 million for vehicle development calling for engineering design of $65.9 million for the first stage, $46.9 million for the second stage, $2.6 million for the guidance system, and $5.8 million for system integration.

Procurement of flight and expendable hardware will include only $6.3 million for the first stage, $4.1 million for the second stage, and $1 million for system integration.

Engine procurement will be funded at $3.1 million, and $28.4 million is the estimated cost of system support.

• **Saturn C-1**—Major emphasis in Fiscal '63 for the large 1.5-million-lb.-thrust booster will be third, fourth, and fifth flights in the 10-vehicle development series. Manufacturing of the sixth and seventh vehicles will reach advanced status, and manufacturing of the final three flight test models will be initiated.

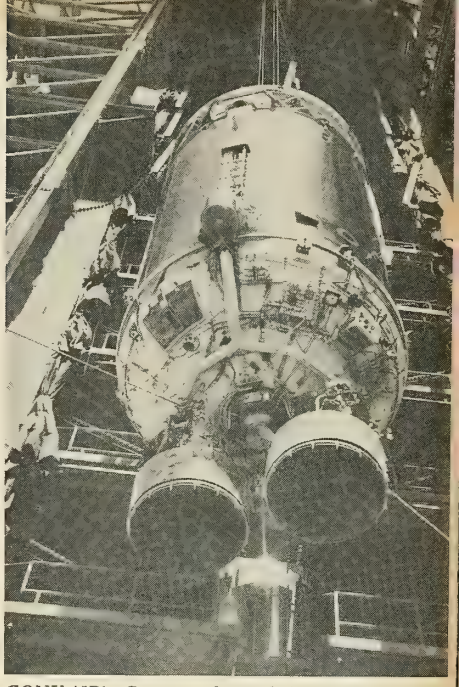
NASA's total request is $249.2 million—$155 million for vehicle development, $36.7 million for engine development and $56.9 million for systems support.

Details of the vehicle development budget include $73.4 million for engineering design; $27.5 million for the first stage; $23.5 million for the second stage, $7.4 million for the guidance system.

Procurement of flight and expendable hardware totals $82 million—including $47.5 million for the first stage, $18.8 million for the second stage, $9 million for the guidance system and $6.6 million for system integration.

Engine development funds will be used for engineering design and procurement of the engines required by the last three *Saturn* development flights, including $11 million for H-1 and $25.7 million for A-3.

The space agency's request for system support includes $22 million for ground support equipment; $9 million for ground instrumentation, $14.2 million for launch operations and $10.8 million for procurement of propellants.



CONVAIR's Centaur, shown being mated to Atlas, was to be fired last week.

• **Centaur**—NASA plans to spend some $46.9 million for development of the *Centaur* vehicle in Fiscal '63. Other major funding areas in the liquid hydrogen-liquid oxygen-powered upper stage are $11.1 million for engine development and $8.5 million for system support.

The vehicle development program calls for $7.6 million for design of the *Centaur* vehicle stage, $13.8 million for fabrication of the vehicle, $7.4 million for procurement and modification of the *Atlas*, $7.4 for ground-testing and $10.7 million for launch support.

• **Scout**—Fiscal '63 funds will be used to complete qualification of the solid-propulsion vehicle and institute a motor improvement program.

Of the $8.9-million total, $1.8 million will be used for vehicle development and $1.4 million to modify the existing guidance system and develop a lightweight fourth-stage unit.

Modification of the second-stage motor will cost about $4 million.

• **Delta** — Only $268,000 is requested in Fiscal 1963 to complete evaluation and final review of the development program of the three-stage launch vehicle, used to launch a variety of scientific, meteorological, and communication satellites and space probes.

• **Launch vehicle technology**—The total request is $31.6 million—$7.4 million for advanced systems studies and $24.2 million for vehicle technology. ⌘

Bulk of Propulsion Funds Going for Liquids

THE CIVILIAN space agency is asking Congress for a little more than $305 million to support the agency's propulsion effort for Fiscal 1963.

More than half this money is scheduled for the liquid-propulsion program.

The nuclear propulsion program scored the greatest percentage gain, tripling its funding over the previous year. This is because tests of the complete engine are due in Fiscal 1964, and flight tests in calendar 1966-7.

NASA solid-propulsion funding continues at a low ebb, but officials say that if technological developments warrant, the agency will ask for a supplemental budget increase.

• **Electrical propulsion** — NASA's $31-million electric-propulsion program anticipates four typical missions for electric units in 1967-75:

—Vernier corrections of satellite orbits and space vehicle trajectories.

—Interorbital transport of large payloads from low orbits to higher orbits about the earth.

—Transport of large payloads from low orbits about the earth to low orbits about the moon.

—Manned and unmanned planetary and deep space probes.

Leading contenders among the various types of electric propulsion systems are the arc-jet, ion-jet, and magnetohydrodynamic (MHD or plasma) jet.

Requested Fiscal 1963 funding for advanced research in electric propulsion, in millions of dollars:

Ion rocket-engine research—ion generation and acceleration, $2.3; propellant research, $0.9; beam neutralization, $1.1.

Arc-jet research, $1.1. Plasma-jet research $4.0. General research—propellant feed systems, $1.2; high-vacuum research, $0.6; mission analysis, $0.9.

For advanced technical development:

Prototype development—1- and 30-kw arc-jet engines, $2.0; 30-kw ion engine, $5.0; advanced systems and components, $3.8.

For flight programs:

Test and evaluation support, $1.4; flight packaging, $3.8; vehicles, $2.5.

• **Liquid propulsion** — Aim of NASA's $163-million liquid-propulsion program for Fiscal '63 is to develop reliable rocket engines able to: (1) support development of launch vehicles; (2) anticipate requirements for space operations such as rendezvous, lunar orbiting and landing, and planetary flight; and (3) undertake advanced design and experimental investigations.

Accordingly, the liquid-propulsion programs call for developing a small number of reliable, appropriately-sized engines able to meet mission requirements. These engines are the 1.5-million-lb.-thrust RP-1-oxygen engine (F-1), the 200,000-lb.-thrust hydrogen-oxygen engine (J-2), and the 1-million-lb.-thrust hydrogen-oxygen engine (M-1).

Requested funding for the F-1, in millions of dollars, is:

Design, $0.4; component development, $8.4; component test, $10.5; engine development, $12.5; engine test, $10.6; fabrication and test equipment, $4.5; propellants, $8.3.

For the J-2:

Design, $0.4; component development, $4.8; component test, $6.1; engine development, $6.9; engine test, $7.5; fabrication and test equipment, $4.1; propellants, $9.1.

For the M-1:

Design, $0.9; component development, $9.1; component test, $10.0; engine development, $11.1; engine test, $7.7; fabrication and test equipment, $3.3; propellants, $13.3.

For analysis and experimental development:

Launch vehicle engines, $7.9; spacecraft engines, $5.8.

• **Solid propulsion**—The $8-million solid-propulsion program proposed for Fiscal '63—about one-twentieth the funding of its liquid counterpart.

Requested funding for systems and components development for solid propulsion, in millions of dollars, is:

Mission, motor and system studies, $1.0; solid-motor feasibility demonstration, $2.1; motor subsystem investigations, $2.4; components and materials, $1.9; storage and environment effects, $0.6.

(Continued on page 34)

NASA Requested Funding for Propulsion

(in millions of dollars)

	FY 1961	FY 1962	FY 1963
ELECTRIC PROPULSION			
Adv. research	4.575	6.659	12.198
Adv. tech. develop.	2.204	5.770	10.725
Flight Programs	0.385	5.152	7.724
Sub-Total	7.164	17.581	30.647
LIQUID PROPULSION			
1.5-million-lb.-thrust engine	50.849	56.798	55.316
200,000-lb.-thrust hydrogen-oxygen engine	18.574	37.885	38.732
1-million-lb.-thrust hydrogen-oxygen engine	.....	(supp.) 26.000	55.316
Analysis, exp. systems, component develop.	3.303	9.218	13.738
Sub-Total	72.726	129.901	163.102
SOLID PROPULSION			
Systems & components dev.	1.899	4.297	7.944
NUCLEAR PROPULSION			
Adv. research	2.671	3.146	8.029
Adv. tech. develop.	1.500	33.200	61.800
Flight programs	0.398	1.420	33.945
Sub-Total	4.569	37.766	103.774
TOTAL	86.358	189.545	305.467

Electronics Market Trebled Since '61

THE NASA MARKET for manufacturers of electronic components is climbing steeply.

NASA spending on tracking and data acquisition systems is budgeted for an increase of nearly 60% over the Fiscal '62 figure. This means Fiscal '63 money for these electronic systems will be more than three times the FY '61 level.

NASA plans to spend some $158,410,000 on these systems in the year ahead, compared to $94,844,000 in 1962 and $44,330,000 in 1961.

Biggest increase will come in money for equipment and components. Spending in this area during FY '63 will be $74,645,000, compared to $26,417,000 in the current year.

The budget for systems development goes up from $13,051,000 to $15,950,000 and for network operations from $55,376,000 to $67,815,000.

The '63 NASA budget for equipment and components in this field breaks down this way (in millions of dollars):

• **Satellite network** — Maintenance, spares and replacement, $6.788. Spending for expansion of network capability: antennas, $4.674 receiving and recording, $3.168; command, $2.175; data handling and processing, $1.654; tracking, $1.781. Total for the satellite network: $20.230.

NASA officials say higher-gain ground antennas are required for the network in view of the increase in the number of satellites, which has resulted in a corresponding increase in the bandwidth or amount of information transmitted per unit of time. Provision of 136-megacycle yagi self-tracking antennas for all stations is to be completed in Fiscal '63. Mobile stations of medium bandwidth capability, between the yagi type and the large data acquisition facilities of the Alaska type, will provide perigee coverage for *Eccentric Geophysical Observatories* as well as emergency support to other observatories and satellites.

New receiving, detection and signal conditioning equipment will be required to support telemetry requirements. Ten stations are slated for installation of pulse code modulation systems, including signal conditioning, synchronizing and decommutation instrumentation plus display equipment.

NASA FY '63 Budget for Tracking and Data Acquisition

	1962	1963
Systems Development	$13,051,000	$15,950,000
Network Operations	55,376,000	67,815,000
Equipment and Components	26,417,000	74,645,000

Procurement and installation of specialized command instrumentation—including antennas, transmitters and encoders—will be completed at ten stations in FY '63. Special real time read-out telemetery also will be installed at several sites.

• **Manned flight network**—Maintenance, spares, and replacement, $3.269. Spending for expansion of network capability: PCM ground station equipment receivers, recorders, discriminators, demodulators, $14.379; S-band ground-to-capsule data and voice communications systems, $5.882; modification of telemetry and acquisition aid systems, $5.882; control center equipment, $2.615; ranging and positioning equipment for terminal trajectory instrumentation, $2.615; FM/FM telemetry equipment, $1.308. Total for the manned flight network: $35.950.

NASA says additional equipment is required at *Mercury* and other existing sites to provide tracking, communication, control and telemetry capability for the *Gemini* and *Apollo* spacecraft.

PCM telemetry ground equipment is needed at all stations and real-time telemetary read-out equipment is needed at certain sites. For *Apollo*, initial installation of S-band ground-to-capsule communication, telemetry and tracking equipment will begin at some sites to provide the capability of monitoring R&D S-band equipment. S-band communication will be used on the *Apollo* lunar mission to insure compatibility with the existing DSIF network.

• **Deep-space network** — Maintenance, spares, and replacement, $4.095. Spending on expansion of network capability: masers, $1.396; recording and data processing instrumentation, $0.785; modifications to DSIF antennas, $3.050; multi-channel receivers and automatic detection and frequency acquisition, $2.789; automatic checkout and calibration equipment, $3.316; precision ranging, $1.569. Total for the deep-space network: $17.000.

Spare and replacements for equipment in the deep-space network include such units as generators, pumps, and hydraulic and electrical machinery. Stepping up of operations to a full three-shift, seven-day week in FY '63 will require increasingly heavy replacement of equipment.

NASA says several improvements are required at the DSIF stations. Masers will be installed at all stations to reduce the noise level of electronic equipment. Additional data recording and handling equipment will be installed for the *Mariner* and *Surveyor* programs.

Antennas will be modified to convert them from prime-focus-feed to a Cassegrain feed system. Multi-channel receivers capable of receiving transmissions from more than one spacecraft on the moon, and automatic detection and frequency acquisition electronics, are to be installed at all DSIF stations.

• **Ground communications network** —A total of $1.465 in all areas—including updated terminal equipment, video monitoring facilities and test equipment. channelization equipment and circuit assurance and checkout equipment.

• **New systems**—In addition to improvement of existing systems, NASA plans considerable R&D on new tracking and data acquisition systems.

The agency says the extensive use of large reflector antennas in ground instrumentation has brought to light many deficiencies in present-day antenna equipment.

One antenna area which will receive attention is that of the basic drive systems. Development will concentrate on electrical-drive systems to replace present hydraulic-drives. Other areas where improvement is needed include eddy-current clutches and differential drives. ❖

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One answer to the tough hydrofoil propulsion problem could be the Martin Co.'s underwater ramjet, for which the firm recently won a $40,000 contract from the Navy's Bureau of Ships. Object is to see if the company's Marjet—an underwater marine propulsion system that uses a mixture of forced air and water instead of propellers—can be used to power very large, high-speed hydrofoil ships.

ADVANCED MATERIALS

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High-Pressure Test Cell Perfected

A simple piston-cylinder system has been modified for simultaneous pressure and temperature applications by engineers at Wright Field. The device is capable of pressures up to 20,000 atmospheres and temperature up to 1700°C. It uses an internal furnace made of carbon-silicon carbide requiring less amperage than a comparable graphite unit. The specimen chamber volume was increased through boron nitride and mica insulation techniques.

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NORTHROP

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Technical Countdown

ELECTRONICS

IATO Laser Symposium Held

Western scientists met last week in The Hague, Netherlands, to discuss the present state of the art in laser technology and its potential military applications. Sponsored by the Assistant Secretary General for Scientific Affairs of NATO and the SHAPE Air Defense Technical Center, the conference was attended by over 150 scientists on an invitation-only basis.

am- and Fool-proof Radars?

To counter the effect of loss of target on tracking radars (due to either natural or man-made interference), Sperry Gyroscope engineers have developed a computer prediction method to keep a high-performance 3-D radar tracking at the correct rate and in the proper direction. The computer, using inputs stored up to the time of target loss, is believed ideal for taking advantage of the limited maneuverability of high-speed aircraft and guided missiles.

vco to Handle Zeus Target Study

A six-month contract has been awarded by Bell Telephone Labs to Avco Research and Advanced Development for a study of ways to enhance the capability of *Nike-Zeus*. The work will include investigation into other problems such as information handling, guidance and communication correlation.

ASW ENGINEERING

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Missile Shock Detector Goes Commercial

A tiny mechanical unit that indicates rough handling has long been attached to sensitive missile components shipped from General Dynamics/Electronics. About 5000 of the units have been delivered to the Navy, which uses them to check on unreported rough handling in the shipment of crated parts. Various models now commercially available have shock ratings from 5 to 50 g's. Also being marketed are electric contact models which permit checking without opening the crate.

Ultra-Pure Cadmium Selenide Prepared

IBM researchers have developed a convenient laboratory method for preparing ultra-pure cadmium selenide and related compounds. The process permits a low-temperature synthesis of CdSe directly from the elements. Very fine powders of Cd and Se are heated slowly to a temperature of 450°C in a high vacuum. The heating rate must not be greater than 0.5°C minute, and the particles must be smaller than a certain critical size (the latter discovery is the key to the method). Under these conditions, the elements react completely to form the photoconducting compound.

New Concept in Cutting Tools

Cutting tools with permanent bodies and removable carbide inserts with two to four cuttings edges have reached the marketing stage at Wesson Corp. The firm developed the inserts in response to complaints from the missile industry about the cost of carbide end mills. Since only the indexable, low-cost inserts have to be replaced, the tool cost per cutting edge is considerably reduced.

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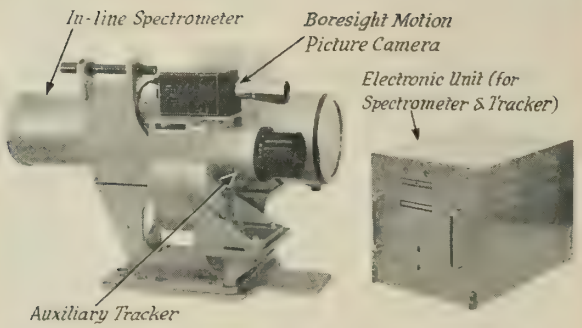


LEFT: *Typical construction of in-line spectrometer shows compactness of instrument, and advantage of having entire optical system aimed along line of sight. Shelf-mounted auxiliary tracker is used for locking instrument on a fast-moving target. Boresight camera records field of view presented to spectrometer and tracker. Two units weigh total of about 135 lbs.*

RIGHT: *Installed aboard the "American Mariner" for Project DAMP re-entry investigations, this Barnes in-line spectrometer (at extreme outboard position) utilizes 12 infrared detectors for simultaneously recording radiation in 12 narrow spectral bands. Other instruments shown include a four-channel photometer and a boresight camera (inboard side, being loaded)*

optics

System Exploits Converging Light

AN UNUSUAL lens configuration has made possible the development of an in-line spectrometer that permits effective use of non-collimated light with reflection gratings.

Lightweight and occupying 1/15 the space required by more conventional systems, the spectrometers provide single-plane focus and can be provided with as many as 50 detectors for studying high-velocity radiating objects.

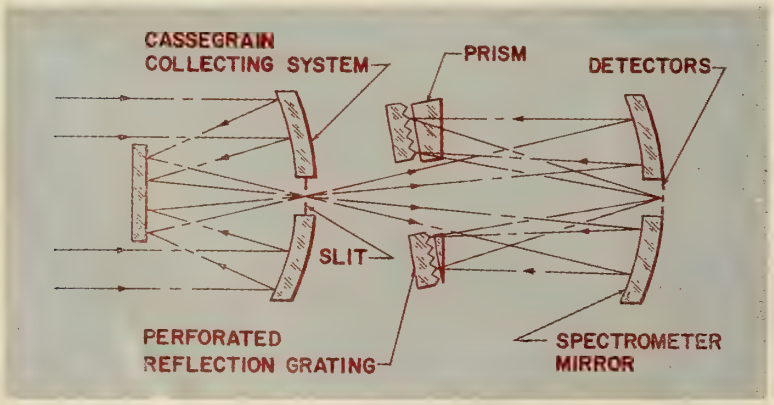
With relatively simple modification of optics, the instruments can be used for spectral analysis of frequencies from the ultraviolet to the far infrared.

A generally accepted dictum in the optical field has been that only collimated (parallel) light can be used effectively with reflection gratings in spectrometers. However, Dr. R. Bowling Barnes and P. Wardham Collyer, both of Barnes Engineering Company, have shown through a new spectrometer that converging light can be used with a reflection grating.

The system was patented last summer (U.S. Pat. No. 3,003,026), and a variety of spectrometers have been built using the new approach.

The major advantage of using converging light in spectrometers is the fact that it permits construction of an "in-line" instrument. Light rays received at one end travel straight through the spectrometer, are filtered into narrow wave bands and dispersed into a useful spectrum, and may then be photographically or electronically recorded at the opposite end.

The company believes that because the optical elements are mounted all in a line, and need not be shifted off-axis, a much more compact, noticeably lighter instrument can be constructed—an obvious advantage for missile applications. A typical in-line instrument measures about 6 in. in diameter by 24 in. long. This compares favorably with the 2000 cu. in. of space required by conventional apparatus of this type.



OPTICAL DIAGRAM of in-line spectrometer. Note the effect of the correcting prism in bringing all rays of a given wavelength to a common focus at the detector or image point. Each detector shown off the optical axis also receives all rays of another nearby wavelength. (When the prism is not employed, a great confusion of rays occurs after diffraction from the grating.)

• **Tracking simplified**—In addition to reducing weight and size of the spectrometer, the new approach presented by Barnes and Collyer appears to offer greater design flexibility. All optical elements are mounted in a tubular housing, so that they may be built easily as modular subassemblies for final assembly in the field. In case of damage, replacement of an entire module will quickly return the instrument to active service.

The in-line instrument, the developers say, offers another important advance over those built along conventional lines: it is inherently easier to aim and lock on target. This can be particularly critical when the spectrometer is used for missile re-entry studies—or for any other problems of a similar

fast-moving nature.

With conventional spectrometer construction, converging rays of light, impinging on a reflection grating, would not be brought to a focus because of the difference in optical path length for different rays. The new technique described by Barnes and Collyer solves the problem.

The in-line spectrometer uses a correcting prism, interposed ahead of the reflection grating. The prism is designed so that its differential refracting effect on rays of various inclination exactly compensates for the difference in light path length. Thus, all rays contributing to the resulting spectrum lines will focus in one plane.

• **Versatility** — The spectral output of the instrument is used in several ways, depending on the design of the instrument. In some cases, the complete spectral analysis is recorded on film. In others, a single detector is used for sequential determination of the various wavelengths.

Finally, a third type of instrument uses a series of detectors—as many as 50 elements—for simultaneous conversion of the optical signals into electrical outputs. These may be telemetered to ground stations for observation, or taped on multi-channel recorders for subsequent study.

The in-line spectrometer, according to the designers, may be built as a very "fast" instrument having an aperture ratio of f/2 converging on the grating. They believe that use of appropriate detectors and grating/prism combinations will make the instrument suitable for analyses over a wide range.

Barnes Engineering so far has built three types of in-line spectrometers. One uses a single detector, for any given set-up, together with a rocking grating/prism combination. A second model is equipped with high-speed photographic film, for recording an entire sequence of events. ⁂

optics

Ruby Laser Transmitter May Be Key to Rendezvous

AN OPTICAL RADAR unit which uses a ruby laser transmitter may help bridge the critical gap between a manned spacecraft and target vehicle as they approach a rendezvous docking point (M/R, Jan. 8, p. 14).

Built at the Martin Co.'s Orlando Aerospace Division, the unit is packaged in a suitcase occupying a volume of 1.6 cu. ft., and weighs approximately 60 lbs.

As the laser pulse is transmitted, a sample is picked off by a photomultiplier, amplified and used to open a gating circuit, which has an input from a 9.835 mc clock circuit. The return signal is picked up by a second photomultiplier, amplified and used to close the gating circuit. The number of cycles the oscillator completes between the transmitted pulse, when the gate is opened, and the received pulse, when the gate closes, is counted by a 10 mc counter and then displayed in a digital form on an in-line readout.

• **Laser transmitter** — The laser transmitter consists of a ¼ in. by 2 in. silvered ruby with one end partially transmitting in a silver-plated elliptical reflector. The ruby is powered by an EG&G FX-38 flashtube, which in turn is powered by a 525-uf capacitor bank that may be charged as high as 900 volts. The power pack can supply 212 joules electrical input to the flashtube. Laser output is collimated by a two-element lens system—the eyepiece has a focal length of 0.87 cm, the objective lens a focal length of 8.69 cm.

This system is theoretically capable of giving a beam width of less than one milliradian, with a lens separation of 9.58 cma and a ruby beam width of 5 milliradians. Beam widths observed so far give a divergence of 1.5 to 2.0 milliradians, which is in agreement with calculated values. Improved collimation can be obtained by using a longer focal length objective.

• **Receiver**—The receiving lens has a 12-cm diameter with a focal length of 34 cm. To reduce the effects of background light while still passing the laser return signal with minimum attenuation, a 10-angstrom filter is placed between the receiving lens and photomultiplier tube. A fixed-field stop is used to yield a 1 milliradian field of view.

A Type 7265 photomultiplier was chosen for the receiver because of its very high gain and maximum spectral response. A 1P22 photomultiplier is used to detect the initial pulse from the transmitter, with a 100-Angstrom filter placed before it to insure that only laser light would open the gating circuit.

Solid-state video amplifiers are similar, and have gains in excess of 30 db and bandwidths greater than 10 mc. To prevent low-level noise spikes from actuating the gate, base clippers are provided. When a detectable signal is present, the amplifiers provide a minimum of 4 volts to the gate.

The gating circuit previously mentioned has an input from the 9.835 mc clock. The clock circuit consists of a solid-state crystal-controlled oscillator with its amplifier. The choice of clock frequency stems from the desire to use 10-mc counter circuitry and count in 50-ft. intervals. The time lapse for a two-way path is 6.66 ns per meter or for a 50-ft. path, the time is 102 ns, representing a frequency of 9.835 mc.

Within the counter, using 50-ft. intervals, the first digit is always zero and the second either zero or five. Conventional counting methods are employed to yield the necessary number of digits to describe the given range.

Thirty Yardney YS-2 Silcad cells supply enough power for approximately one hour of continuous operation. Control circuitry holds the range reading for 30 seconds, then automatically resets for another range measurement.

A breadboard model of the optical radar ranging set has been checked out and returns have been obtained to 3.5 miles with a 10-db signal-to-noise ratio. Calculations indicate that with a laser output of 750 watts (in the atmosphere) ranges of six miles should be easily obtainable on a clear day. In a space application much greater ranges are possible.

With the use of a higher frequency counter and with more efficient lasers, accuracy and reliability can be greatly enhanced. Concentrated effort on miniaturization should reduce the unit weight by half (to about 30 lbs.), with a noticeable reduction in volume.

Martin engineers R. E. Johnson, J. E. Ticen and A. P. Sheppard say the unit was built to demonstrate the feasibility of a completely portable ranging unit which would offer accuracy and permit simple operation. ⁂

Fuel Cells Lead Apollo-Gemini Field

P&W seen likely to win $15-million Apollo award, GE to get $8 million for Gemini—Cryhocycle a contender for possible backup

by William Beller

THE NATIONAL Aeronautics and Space Administration has earmarked a total of about $23 million for developing space-power systems for *Gemini* and *Apollo*.

Most of this money probably will go to Pratt & Whitney Aircraft, a division of United Aircraft Corp., which is negotiating a fuel-cell contract for about $15 million with the *Apollo* prime contractor, North American Aviation, Inc. The remaining $8 million probably will go to General Electric, which is working out a fuel-cell contract with the *Gemini* prime contractor, McDonnell Aircraft Corp.

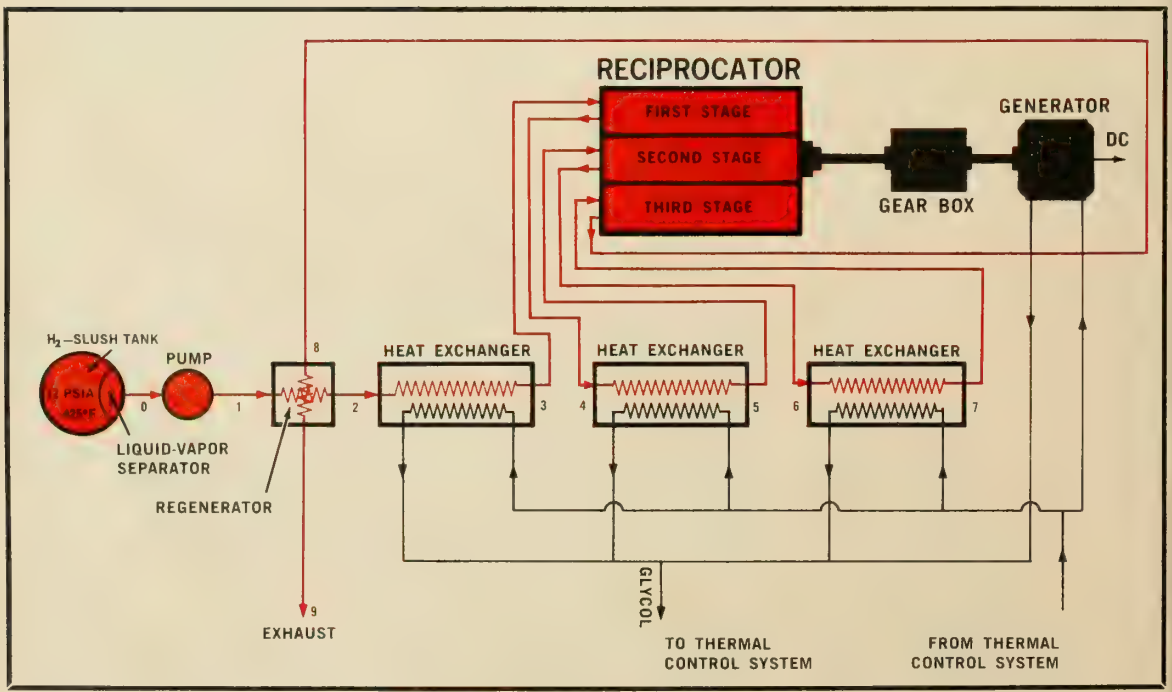
• **Other systems studied**—No back-up space-power system is contemplated "at the present time" for either of the spacecraft projects, a high NASA official told MISSILES AND ROCKETS. He labeled "incorrect" the widely published story that TAPCO Div. of Thompson Ramo Wooldridge had been awarded a competitive contract—along with Pratt & Whitney—for developing the *Apollo* fuel cell.

The official hastened to add that the situation could change—if the contractors lag in their development of fuel cells, or if a more conservative approach is adopted, requiring the back-ups.

For this reason, a small internal study of back-ups is being pursued at the space agency. Scheduled to be finished in two or three months, the study is to prescribe which back-ups to use if any are needed.

NASA freely admits that fuel cells and solar cells are the likeliest contenders for back-up systems. Nevertheless, the agency spokesman said that all possible systems are being studied without prejudice. These include thermionic, thermoelectric and cryogenic systems.

The Cryhocycle—a cryogenic concept developed by Sundstrand Aviation Div. of Sundstrand Corp.—was a late starter in the *Apollo* program, being introduced only after proposal requests



CRYHOCYCLE—proposed for space-power system and thermal control suitable to an Apollo-style mission.

for *Apollo* went out specifying that fuel cells be used for space power.

The first public demonstration of Cryhocycle hardware with a reciprocating prime-mover was carried out successfully at Sundstrand last week, company officials anticipating that their cryogenic concept would be ideal for *Apollo*-type missions.

• **Fuel-cell back-ups**—The merit of the possible use of fuel cells to back up fuel cells was defended on the basis that there are fundamental differences in the operation of the four fuel-cell systems offered to NASA for *Apollo* and *Gemini*. Pratt & Whitney proposed a Bacon cycle; General Electric, a single-membrane ion exchange; the team of TAPCO and Ionics, Inc., a dual-membrane ion exchange; and the team of Allis-Chalmers Manufacturing Co. and Minneapolis-Honeywell, an asbestos-membrane ion exchange.

It was further pointed out that there are also differences in the sub-components—some fuel-cell systems using centrifugal methods for water separation, and others using osmotic.

• **Candidates for Apollo power**—The *Apollo* mission prescribes a peak-power output slightly less than three kilowatts, an average power output of two kilowatts, and availability of this power for 336 hours (14 days).

Batteries were discarded because of their heavy weight and excessive volume compared with other power-generation means. However, batteries are to be carried in the *Apollo* command module to furnish power during the spacecraft's re-entry phase. The fuel cells are to be left with the service module, which is to be detached prior to re-entry.

Solar cells were also considered and rejected: solar panels would be difficult to structurally integrate into a spacecraft; they would be difficult to deploy and orient; they would require either batteries or fuel cells for use when the spacecraft is on the dark side of the Earth or moon.

The thermionic systems offered promise, but unfortunately the state-of-the-art was not expected to be sufficiently advanced for either the *Gemini* or *Apollo* missions. Two major difficulties were seen: no adequate solution to the problem of space-charge neutralization; and the high-operating temperatures required for the thermionic diode, resulting in serious materials problems for the electrodes and for the gas-enclosing envelope.

Similarly, thermoelectric systems lag in development with respect to *Gemini* and *Apollo*. There is also a materials problem here: finding materials for thermocouples which have high electrical conductivity and, at the same time, low thermal conductivity—seemingly contradictory requirements. Moreover, if two kilowatts are to be drawn from a thermoelectric device, efficiencies must be obtained much higher than the 5-10% demonstrable now in practical devices.

• **Cryogenics a possibility** — The Cryhocycle has the advantages of high reliability, being well within the state-of-the-art, and probably having lower weight for the *Apollo* lunar mission than fuel cells. The disadvantage is that the Cryhocycle would need about three times the volume of a nominal two-kilowatt fuel-cell system.

In the Cryhocycle, energy is extracted from waste heat and converted into useful power. This assumes a low-temperature, highly efficient system which can also be used as part of—perhaps even the entire — thermal-control system.

The temperature-entropy diagram shows the system operating as an open Rankine cycle. For the *Apollo* mission, the Cryhocycle is described as meeting the electrical performance specifications with an average specific-propellant-consumption of 0.925 lb/kw-hr, a total system weight of 1187 pounds, and a total volume of 142 cubic feet.

In this cryogenic system recommended for *Apollo*, a slush of hydrogen at 12 psia and −425°F is stored in a tank. A liquid-vapor separator releases the liquid phase to a pump which, in turn, sends the liquid through a regenerator. Here some of the energy in the hydrogen exhaust is picked up, turning the hydrogen working fluid into a vapor.

The vapor then passes through successive heat exchangers, with interstage expansions in a reciprocator. In an earlier concept, the prime mover was a turbine.

In the glycol circuit, heat is carried from the cabin and machinery and is given up to the hydrogen in the heat exchangers. Sundstrand engineers say that suitably regulated the system can give the *Apollo* spacecraft a complete thermal-control system as well as full electrical output.

Here are other advantages listed by the engineers:

—The small weight advantage the Cryhocycle has over fuel cells for the two-kilowatt power level is substantially increased as the power level is increased.

—There is no need for radiators; therefore, there is precise temperature control without concern for micrometeoroid protection or damage.

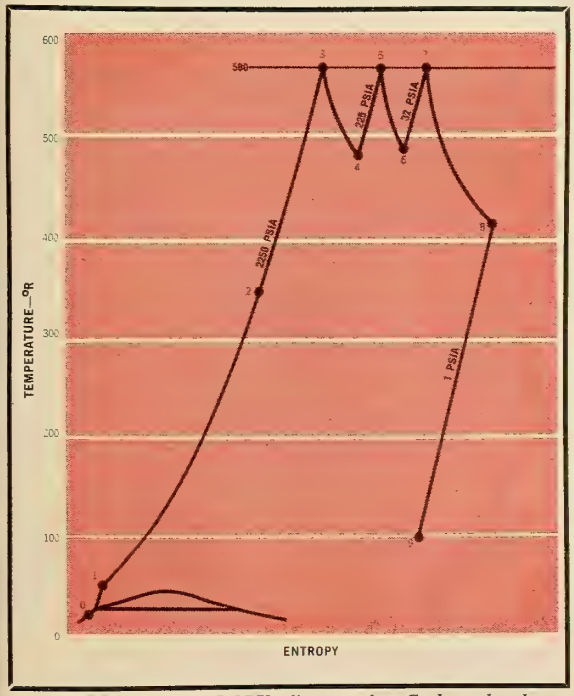
—The Cryhocycle provides vehicle cooling without regard to the ambient environment; hence, the system can be used for all lunar operations.

—The system operates at relatively low temperatures, 120°F to 140°F, which substantially contributes to high reliability—presently calculated to be 0.9972.

—The Cryhocycle system can be converted into reliably working hardware in eight months.

Sundstrand engineers also feel that if the *Apollo* service module had been designed to accept the Cryhocycle, the cabin's exterior dimensions would have changed very little from what they will be with the fuel-cell system installed.

Despite the Cryhocycle's seeming merit for the *Apollo* spacecraft, the space agency hesitates to veer from using fuel cells, principally because they are showing so much promise. "People who looked at them a year ago are amazed at the amount of progress made to date," a NASA engineer recently remarked. ⁂



TEMPERATURE-ENTROPY diagram for Cryhocycle shown.

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Precision-Welding Big

CONTROLLED precision-welding of massive structures with a minimum of tooling and adjustment by the operator is easily attained through a Process Equipment welding unit developed by the Special Products Dept. of Air Reduction Co.

The unit may be instrumental in fabrication of the huge *Saturn* tanks. Both North American Aviation and Boeing have shown interest, and there are possible applications in the *Titan III* program.

The welding device hugs a pre-laid track on the structure to be welded either vertically or horizontally, guided by both optical and electronic instruments. The optical pick-up operates electro-optically, using both an illuminating unit and an optical scanning head to detect the position of a black-on-white line reference—a line laid near the seam and fully correlated to it.

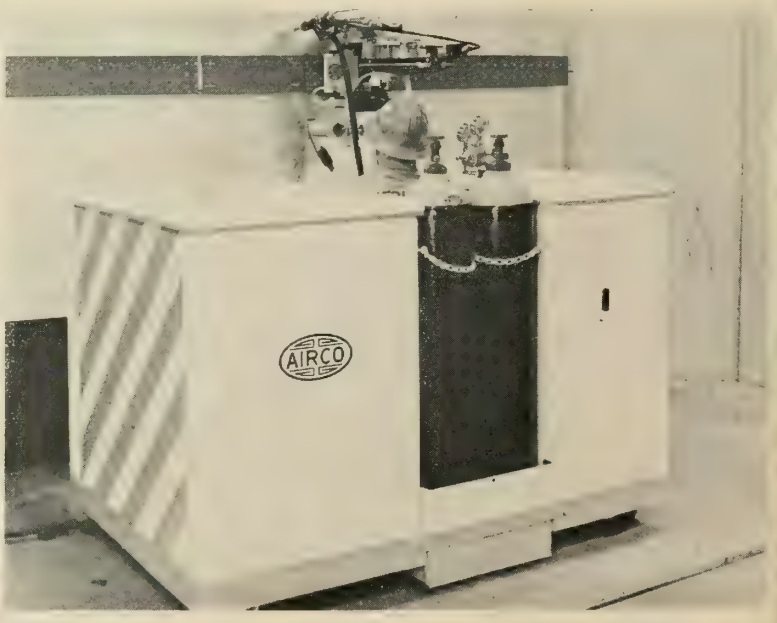
Unbalance in alignment of reference line and scanner results in unbalance of light fed to the photo-cells of the scanner. The error signal is fed through a cross-seam positioning servo which restores the optical head and the attached weld head to the null position.

A proximity positioner maintains separation of contact tube and workpiece at the selected distance. Signals from this unit actuate the positioner's servo mechanism, which operates in a closed loop to maintain the desired arc length.

Signals from the optical pickup actuate the servo mechanism of the cross-seam servo positioner. The positioner holds the welding barrel in precise alignment with the edges of the workpiece. This positioner is attached directly to the skate and can handle reference signals from other seam tracking systems if the application warrants.

Airco's weld skate runs on an aluminum track—furnished with drilled holes and suction cups. The track can be either bolted to the workpiece or held in place with the suction cup system. It comes in 10-ft. lengths, straight or curved to specifications.

• **Fixed control**—The main control station consists of four demountable assemblies. Each unit contains the adjusting potentiometers, selector switches and control buttons for the particular



LEFT: *The operator's tram is a standard unit housing all components and a gas supply. It is synchronized to travel with the moving weld skate.* **RIGHT:** *The weld skate travels along an aluminum track fastened to the workpiece. The welding*

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Structures

welding function regulated.

Initial settings establish the parameter levels and then require no further attention or change—the desired control is maintained through the entire welding operation.

A small, separate panel with switch is provided for start-stop functions. Another selector switch activates either metal arc or tungsten arc components, depending on the process.

The main control station is furnished as either a console mounting on the stationary main control cabinet, a remote pendant station, or a unit in a mobile operator's tram. This last also transports a main control cabinet, gas supply and operator.

The mobile carriage is synchronized to travel with the moving weld skate.

The process brings X-ray-quality welding to large structures without expensive and time-consuming fixturing, says Airco. The package is available in two designs, the operator's tram version and a vertical lift type. Many components are interchangeable, and all control elements are packaged and demountable. ⁂

head is at extreme left, with the proximity positioner behind. The optical tracking system with illuminator is on the right.

MISSILE-SPACE
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The Aircraft-Missiles Division needs exceptional talent to spearhead accelerated growth into selected, key aerospace areas such as satellite and reentry systems, reconnaissance-surveillance systems, communications and power for space applications, and advanced missile systems. Basic prerequisites include appropriate degree, plus a minimum of three to four years' applicable experience.

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Requires increasingly more responsible experience in depth in space, reentry vehicle and satellite programs in control systems, guidance systems, sensor systems, communications systems, propulsion systems, data systems, computers (airborne), vehicle systems (reentry and space), recovery systems, command systems, biological and chemical systems.

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Must have had increasingly responsible experience in depth the last several years of which must have been in systems engineering in one or more of the following areas—control systems, guidance systems, sensor systems, communications systems, propulsion systems, data systems, computers (airborne), vehicle systems (reentry and space), recovery systems, command systems, operations research activities, applied mathematics.

ELECTRONICS ENGINEERING

Requires progressively more responsible experience in depth preferably as related to ballistic missiles, space and reentry vehicles, satellites and associated systems in such areas as data systems, radar, telemetry, tracking equipment, sensor equipment, guidance (command and inertial), control, computers, ground support equipment.

ENGINEERING TECHNOLOGIES

Must have had increasingly more responsible experience demonstrating ability to handle problems in one or more of the following areas—heat transfer-fluid flow, orbital mechanics, trajectory analysis, aerophysics, magneto hydrodynamics, applied mechanics, aerothermodynamics, space dynamics, numerical analysis, calculus of variations, statistics and information theory, materials engineering—metals and non-metals.

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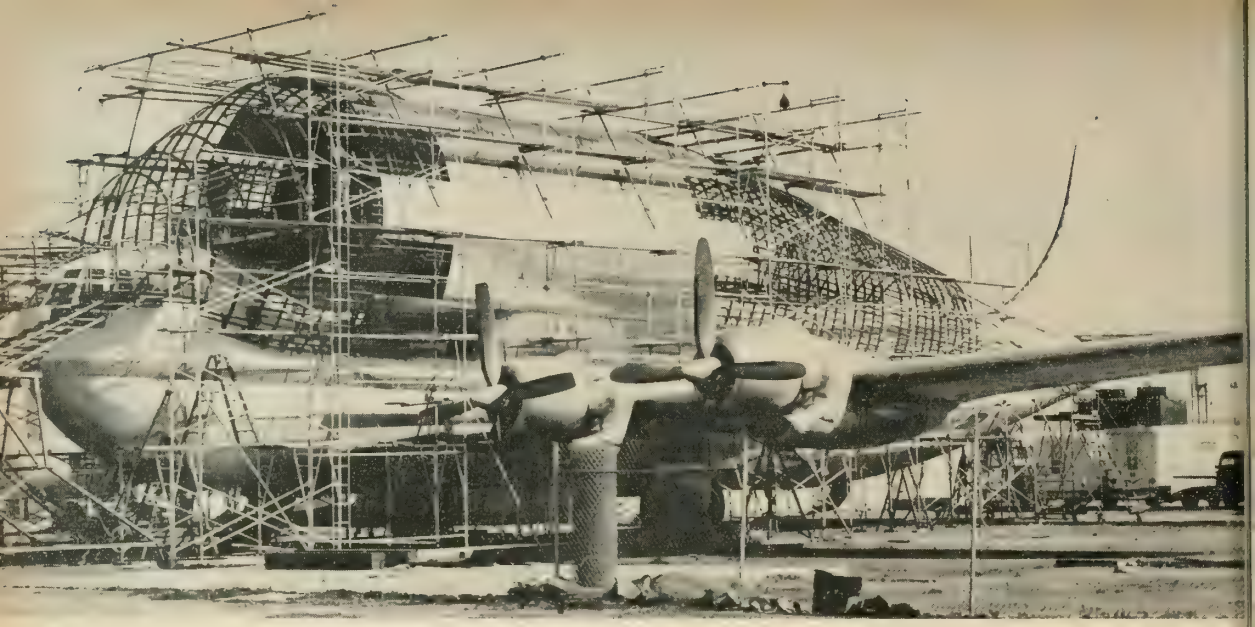


STRATOCRUISER gets 12-ft. roof-raising. Thorough "gutting" will still cut weight.

space support

Aircraft 'Stretched' To Haul Big Boosters

Transport transformed to serve as carrier for S-IV Saturn stage or Apollo capsule; larger version coming

A FEARSOME-LOOKING version of the Boeing Stratocruiser is being developed as a possible transport for big space boosters.

The outgrowth of a little-publicized effort by Aero Spacelines, Inc., of Van Nuys, Calif., the bulbous-topped plane is slated for flight-test in about three weeks. Even more startling adaptations are on the drawing boards.

Two modifications are involved in ASI's conversion of the ex-Pan American Boeing 377. The first, which has already undergone over 10 hours of flight-test, was to stretch the 377 fuselage by adding a 200-in. section just aft of the wing trailing edge. The second alteration, now under final assembly, is a large bubble-like structure over the existing fuselage. This will increase the fuselage inner diameter to over 20 ft., as compared to an original diameter of just under 9 ft.

The aircraft will be split just aft of the wing in a "swing-tail" configuration, but will have a bolt-together joint rather than a hinged section. Cargo will be loaded at this point.

In the present configuration, the aircraft will be able to carry F-1 engines, the *Saturn S-IV* stage, or the *Apollo* command and service capsule. Despite addition of the high structure, aircraft weight has been reduced by all-out "gutting." This helps in payload.

Payload, however, is less of a problem than the sheer bulk of most of the large booster or space vehicle sections. It is anticipated that such loads will be transported at a "shipping" weight, rather than in final ready-for-assembly form. Large boosters or missiles would be shipped with internal pressurization.

• **Further enlarging** — The current design cannot carry the *S-II* or *S-IVb* stages. But a plan is under way to elongate the fuselage of a second aircraft about 344 in., thus in effect increasing the overall average fuselage diameter. Then the concept could carry the larger sections.

After flight tests of the first "enlarged" prototype, the inner, original fuselage will be removed and the removable tail installed. If loads warrant it, two small turbo jets will be installed for "assist" power. ASI is also thinking in terms of using turboprop power in the larger version to achieve desired performance with still higher payloads. Turboprop installation will include considerable additional airframe rework.

If a sufficient demand develops, the company may produce a planned ultra-simple outsize cargo carrier—much of it fabricated from existing components.

• **Tests to decide**—ASI president, John M. Conroy, an ex-AF jet and commercial airline pilot, has been somewhat surprised—considering the lack of publicity—at the interest that has been shown in the project by both governmental agencies and the aerospace industry.

But he holds no illusions about the project. A comprehensive flight-test program is planned for this year. What the company will do from there on out will depend completely upon the test results. ASI has 11 more Boeing 377's that can be converted, although Conroy believes two such conversions will meet immediate requirements.

ASI is an Oklahoma corporation. Board chairman is Loyd G. Dorsett, president and chairman of Dorsett Electronics, Norman, Okla. Vice-president-operations is Kenneth Healy. ⁂

First shot off 'til June . . .

Telstar Communications Undergo Tests

ANDOVER, MAINE—The huge $10-million AT&T satellite communications center here is now being put through shakedown runs in preparation for the first experimental Project *Telstar* launching from Cape Canaveral (M/R, Feb. 19, p. 22).

Originally slated for April, then put off until late May, the first shot of the active-repeater communications satellite is not now expected to go before June at the earliest.

Reasons for the delay are believed to be some minor electronic and mechanical bugs still in the massive 340-ton Andover horn antenna, and also tight NASA launch schedules—including a May date for the next *Mercury* program shoot.

Final pre-launch preparations at this 1000-acre hilltop site are centered around active tests of the main communications antenna. The ability of this antenna, the largest of its kind in the world, to receive and amplify a returning satellite signal estimated at about one-trillionth of a watt holds the key to AT&T investment in workable international telecommunications via satellite.

For the current tests, satellite communications gear has been mounted atop Bell System microwave towers about five miles away from the antenna location, and transmissions have been successfully completed using the horn antenna. Tests have also been made of the antenna's tracking capability, both through stellar monitoring experiments and through use of helicopters carrying *Telstar* communications equipment aboard.

• **New headwear** — The horn antenna and associated cab and drive equipment are also due to get a new protective radome shortly. The temporary inflated covering, 161 ft. high and 210 ft. in diameter, will be replaced by a permanent radome made of dacron and synthetic rubber about 1/16-in. thick. Signal attenuation by the protective cover is said to be negligible.

While work progresses at Andover, overseas ground sites are being readied for participation in international voice, TV, and data communications experiments later this year.

A station identical to the AT&T facility is nearing completion at Pleumer-Bodou, France. The site is expected to be in operation by mid-summer. At Goonhilly Downs in England, an 85-ft. parabolic dish is also being readied for summer operation in order to take part in the tests. In Italy, a 30-ft. dish and transmitting facility located near Milan will be ready during 1963, as will the 85-ft. antenna now under way near Munich, Germany.

In addition to these stations, other international sites are being set up in South America to take part in the NASA Project *Relay* satellite communications experiment which is slated to be put aloft late this summer.

• **Co-op testing**—A special transmitter to be used in *Relay*—a cooperative program between NASA and U.S., South American and European communications companies for testing experimental ComSats—has already been installed at Andover.

NASA will also cooperate with AT&T on the *Telstar* experiments by feeding satellite position data from the string of Minitrack stations to an IBM 1620 computer in the Andover control. These data will assist in aiming the first of three tracking devices which will follow the satellite during its pass through the Andover LOS range.

A quad-helix command tracking telemetry antenna will be pre-pointed toward that spot on the horizon where the satellite is first expected to appear. This device, built by Radiation, Inc., of Melbourne, Fla., will pick up the satellite's 136-mc beacon and telemetry signal and transmit commands over 120 mc which will turn on the broadband communications equipment and also the 4080-mc precision tracking beacon.

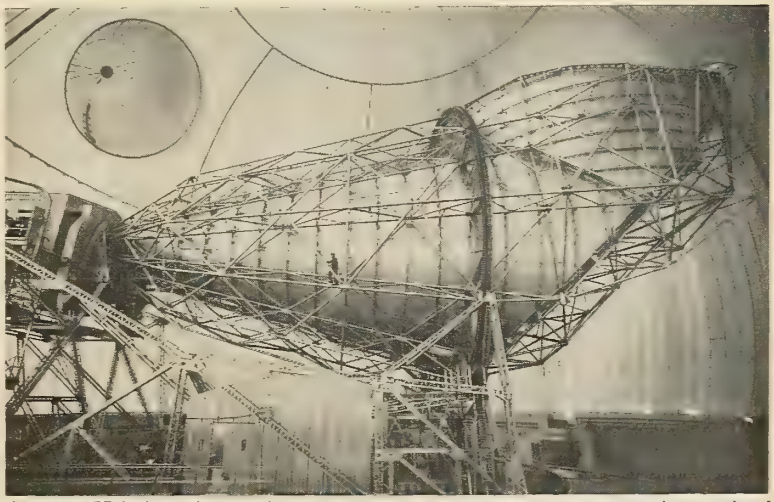
Adjacent to the command tracker is a second antenna—an 8-ft. precision tracking dish reportedly capable of pointing accuracies to 1/100 of a degree. This dish will provide precise positioning data to the immense receiving horn in order to retrieve as much of the extremely weak microwave signal as possible. A vernier autotrack system is employed in the big horn to correct any pointing error.

• **2-kw transmitter**—The communications transmitter installed at the Andover site is a modification of a new Bell System broadband type designated "TH". Power output of the 25-mc bandwidth transmitter is on the order of 2 kw.

At the heart of the receiving equipment are two elements. A liquid-helium-cooled—to 456°F—ruby maser amplifier, and an F-M feedback circuit which acts as an automatic precision tuner.

In order to transmit the information passed via the satellite and major ground installations, the Andover station will be linked to telephone and television networks by a conventional broadband microwave relay system installed and operated by AT&T.

In a projection of things to come, AT&T officials envisioned a string of 20 to 30 ground stations as sufficient to provide world-wide coverage, depending upon the amount of cooperation among the participating countries. Each site would have between three and six major antennas. ⌗



GIANT 177-ft.-long, 340-ton horn antenna at Andover, Maine, was recently completed and is now being given thorough tests in preparation for Telstar launch.

Douglas lashes back . . .

Senate Group Cites Nike 'Pyramiding'

Investigators report big profits went to Western Electric, Douglas on Nike launcher loaders, trailers

by James Trainor

INDUSTRY CONCERN deepened last week as a Senate subcommittee opened hearings on "profit pyramiding."

Donald W. Douglas, Jr., president of Douglas Aircraft, accused investigators for the Senate Permanent Investigations Subcommittee of grossly distorting the facts when they said his firm made 44.3% profit on $103-million worth of components for the Army's *Nike* system.

He said the company's profits as major subcontractor for *Zeus* were completely reasonable, and that the kind of statistics used by the investigators could be applied to virtually any business.

Douglas spoke out after Robert E. Dunne, a Subcommittee staff investigator, reported that "profit pyramiding" may have cost the Army $20.2 million for *Nike* launcher loaders alone.

Dunne said the Douglas company and Western Electric, prime *Nike* contractor, took fees of over $9 million each on work done by a third contractor, Consolidated Western Steel Co.

He later testified that Douglas Aircraft had made 44.3% profit out of the $103 million in *Zeus* sales.

Subcommittee Chairman John McClellan (D-Ark.) said he was not accusing anyone of wrong-doing, or saying that the profits involved were unreasonable.

McClellan did say that the crux of the matter was the fact that Douglas was set up as middle man for development and procurement of support equipment that Western Electric might have obtained direct from the supplier.

Douglas declared it was unfair to use figures based only on procurement as a measure of profit percentages.

Taking into account both procurement and R&D, Douglas said, his firm's sales to the government through 1961 amounted to $939 million. Profits before taxes were $29.8 million—a rate of less than 3.2%, he noted.

• **What happened on Nike**—Testifying as an expert government witness, Dunne told the committee that the total production cost of the *Nike* launcher loaders—including the general and administrative costs—was $146,223,000. For this work, Consolidated Western Steel received a fee of $9,285,000, or 6.3% of costs, from Douglas.

Douglas, in turn, billed Western Electric for the work and added a 6.7% fee which netted the company $10,354,659. Western Electric—the prime system contractor—then billed the Army for the launchers, collecting a 5.7% fee on Western's work of $9,840,475.

Thus, the bill presented to the Army totalled $182,182,070—some $26,674,070 more than the Consolidated Western price and the amount paid by the government. This latter figure contained some $6,478,936 charged against the contract as "general and administrative" expenses by Western Electric.

Dunne pointed out that the profits taken by the two companies over the eight years covered by the contracts were more than the profit received by the producer, Consolidated Western.

Milton Karr, Chief Engineer of Consolidated Western, testified his company's fee was "fair and reasonable."

Karr said that he was not qualified to say why it was necessary to have three sets of profits on the launcher loaders. But he added that as far as he

*Average Profits Paid to Major ICBM Associate Contractors for Work Accomplished Over System Life **

ATLAS

Contractor	Contract Fee	Av. Fee Pd. to Subcontractors	Pct. of Work Subcontracted
General Dynamics/Astronautics	5.5%	5.5	27
American Bosch Arma	6.3	6.5	33
General Electric (Phila.)	7.5	7.0	28
Avco	7.6	7.0	32
North American Aviation/Rocketdyne	6.7	10.0	35
Burroughs	7.0	7.0	28
General Electric (Syracuse)	7.1	(1)	(1)
Space Technology Labs	9.3	....	....

TITAN

Martin	5.9	6.5	45
American Machine & Foundry	5.5	(2)	(2)
Aerojet-General	6.0	(2)	(2)
AC Spark Plug	4.9	7.0	35
Avco	7.1	7.0	32
Remington Rand	6.6	7.0	26
General Electric (Phila.)	7.1	7.0	33
Western Electric	6.8	7.0	37
General Electric (Syracuse)	6.6	(1)	(1)
Space Technology Labs	9.3	.....	....
Paul Hardeman	10.0	10.0	50

MINUTEMAN

Contractor	Fee	Av. Fee Pd. to Subcontractors	Pct. of Work Subcontracted
Boeing	6.1	7.0	55
Thiokol	3.6	7.25	60
Aerojet-General	5.3	7.0	60
Hercules	6.4	7.0	40
North American Aviation/ Autonetics	5.1	6.5	50
Avco	6.1	(2)	(2)
Space Technology Labs	9.2	.....	....

* *Based on official Air Force figures.*

(1) Figures a composite of the work done by both GE Phila. and GE Syracuse.

(2) Not available.

knew Western Electric's only direct participation in the work was to provide consultants and inspectors.

Dunne's figures were challenged during a committee recess by Walter G. Herr, contract manager for Western Electric. Although the committee investigator insisted they were correct, Herr said the numbers were not accurate and, if Dunne were going to use them, he should "get them right." Earlier, Dunne had claimed that his figures came from "company books" and were not a "question of issue."

• **Trailer profits revealed**—Turning to the profits earned on missile transport vans and electronic vans in the *Nike* system, Dunne told the committee that Douglas and Western Electric earned $7 million in "pure profits" on work performed by Fruehauf Trailer Co.

Fruehauf, Dunne said, built an undisclosed number of trailers for $49.3 million. However, he said, after Douglas and Western Electric had added their profits and administrative costs the Army paid $63 million for the vans. Profit percentages for the companies, he said, were: Freuhauf—9.2; Douglas—6.8 and Western Electric—5.9.

R. E. O'Dell, an industrial engineer for the Army Ordnance Missile Command, testified that when the Army began dealing directly with Fruehauf for the trailers it was able to cut the unit price from $12,000 to $10,700.

He also said that in 1958, when the trailer procurement was opened to nationwide competition, the unit price of the trailers was reduced to $5300.

• **AF reveals fee structure**—In testimony released last Thursday, the Air Force revealed the fees paid to its major associate contractors and the average fees which they, in turn, paid their subcontractors (see box).

In establishing appropriate fees, AF officials told the House subcommittee on DOD Appropriations, the Ballistic Systems Division takes into account the complexity of the subsystem or item, the management to be exercised (technical or other), the type and status of existing contracts and the pricing experience with the subcontractor.

Noting that profit pyramiding occurs in normal commercial transactions and is "perfectly normal" in business transactions, Maj. Gen. W. T. Thurman, Director of AF Procurement Management, said that it is "a question of degree as to how far down you go in buying components and putting them together."

• **DOD studying problem** — Information supplied to the House Subcommittee revealed that the Defense Department has launched a major study "reexamining the entire profit and fee policy, including an assessment of whether the policy guidance is sufficiently precise." ⌘

Information Management Attacked by Humphrey

HIDDEN WASTE within the Department of Defense may be costing taxpayers between $1 billion and $2 billion a year in the development of weapons systems and, in terms of time, may be adding one year to the five-year development cycle of a weapon system.

Responsible for these conditions is the "unsatisfactory management of scientific and technical information by the Department of Defense."

These charges were made by Sen. Hubert H. Humphrey (D-Minn.), chairman of the subcommittee on Reorganization and International Organizations of the Senate Committee on Government Operations, in a letter to the chairman of the House Subcommittee on DOD Appropriations, George H. Mahon (D-Tex.).

"No matter how much the contractors spend, or how able or diligently they go about the task," the Humphrey memorandum continued, "they cannot possibly find all the Federal report-type information which they need when they need it.

"As a result, contractor scientists and engineers needlessly repeat work which has been done before, or which is being unknowingly done at the same time, in other locations, or on which there might have been a short cut if ideas had been properly cross-fertilized."

Noting that the House Appropriations Committee had urged DOD to give this matter close attention, Humphrey characterized subsequent Defense efforts as "too little, too late, at too low a policy level, with too little follow-through and too few results—present or prospective."

• **Problem studied in depth** — For the past three and a half years, the Humphrey subcommittee has been studying the problem of the documentation, coordination, indexing and retrieval of scientific information steming from government-supported R&D projects.

The results of these studies which included the comments of scientists and engineers both within government and industry have been published in a series of four Senate reports. The fifth report—"The Crisis and Opportunity in Scientific and Technical Information"—is now in preparation and is the basis for Sen. Humphrey's memorandum.

• **Solution: upgrade ASTIA?**—Asserting that the efforts of tri-service information coordination will remain severely frustrated unless fundamental reforms are instituted, Humphrey advocates an expansion of the overall role of the Armed Services Technical Intelligence Agency.

A 19-point program—designed to remedy the inherent limitations in ASTIA services today—has been developed by the Agency, according to the subcommittee chairman, and, with the proper support of higher authorities, would do much to correct existing deficiencies.

At present, ASTIA has a store of 650,000 documents and processes some 750,000 requests a year. However, since the agency receives only 19% of the total technical reports of DOD prime and associated contractors, its inventory of reports is both quickly outdated and almost totally incomplete.

For example, until recently, the *Polaris* program has generated only 323 reports to ASTIA while the *Minuteman* project has contributed only 128 documents.

Another limitation of ASTIA service, at present, is its inadequate staff. This means that currently, ASTIA requires 18 working days to process a technical request. The agency's goal is to eventually reduce this processing time to one day and, on an emergency basis, to one hour.

• **DOD-level agency needed** — Asserting that there is at present inadequate organization, interest or responsibility for management of scientific and technical information at the DOD level, Senator Humphrey recommends that a small information unit be established in the Office of the Director of Defense Research and Engineering.

This office, the senator said, would evaluate, coordinate and monitor the information activities of the services, advise the Secretary of Defense on the department's future information role and provide liaison with other government agencies involved in Federal information activities.

Decrying any intention to establish another bureaucratic layer at DOD level, Humphrey asserts that departmental-level responsibility for management of scientific and technical information is inescapable.

Additional recommendations for solving the information retrieval problem include: a specific line item in the RDT&E budget for intramural scientific and technical information and, as part of the report of the Committee on Appropriations, observations and requests for reports on DOD's future management of information. ⌘

Space Power Fund Request Up 1/3

THE NATIONAL space agency is asking Congress for slightly more than $20 million for the next fiscal year to fund research and development of space power systems—a request about one-third greater than the amount sought for the same purpose last year.

About two-thirds of the $20 million is earmarked for advanced technical development, the remainder for programs in advanced research (see accompanying table).

• **Solar cells** — Solar-cell research and technology is listed for a combined total of $2.8 million. This is expected to be used, in part, for learning more about the behavior of solar cells and for devising radiation-resistant units. In addition, methods will be sought to improve solar-cell geometry in order to raise the power output per cell.

• **Fuel cells** — Suggested work will lead to prototype fuel-cell systems which, in turn, are expected to aid in solving fuel-cell hardware and reliability problems. In particular, fuel-cell technologists will seek to develop special components such as pumps, controls and water separators.

• **Thermionics** — A broad program is proposed—both in-house and through contracts with industry and universities —with the goal of fuller insight into the thermionics process, plus a solution to the tough materials and fabrication problems connected with the efficiency and life of thermionic devices.

• **Solar concentrators** — NASA is calling for studies aimed at producing mirrors that are lightweight, radiation-resistant and long-lived. This is a continuation of current studies on inflatable, foamed-plastic and rigid honeycomb structures. Complementing this work is a proposed program to develop prototype mirrors, using the materials and fabrication technology acquired under the research program.

• **Other systems** — In magneto fluid dynamic power generation, research in Fiscal 1963 is expected to stress high-temperature containment materials, plasma physics and the generation of high magnetic fields.

Proposed battery studies would yield a better understanding of the causes of self-discharge and polarization; experiments are suggested that could lead to relatively light electrochemical cells.

Before thermal-energy storage is used in an experimental system, NASA wants more data on the thermal properties of possible materials: conductivity, thermal expansion, heat of fusion, and melting and freezing heat-transfer characteristics. ⌘

NASA Requested Funding for Space Power Technology

(in millions of dollars)

ADVANCED RESEARCH	FY 1961	FY 1962	FY 1963
Solar Cell Research	1.090	1.534	2.300
Fuel Cell Research	0.250	0.665	0.900
Thermionic Conversion	0.700	0.970	1.200
Solar Concentrators	0.400	0.600	0.750
Distribution and Control Technology	0.253	0.300	0.384
Magneto fluid dynamic power generation	0.300	0.450	0.500
Battery Research	.....	0.100	0.400
Thermal Energy Storage	0.400	0.266	0.500
Thermal Radiation Properties	0.545	.....	.....
Sub-Total	3.938	4.885	6.934
ADVANCED TECHNICAL DEVELOPMENT			
Solar Cell Technology	0.540	0.600	0.500
Fuel Cell Technology	0.500	0.850	0.750
Solar-Thermionic Power	.....	0.900	1.000
Solar Concentrator Development	0.100	1.030	1.150
Distribution and Control Equipment	0.535	0.950	1.688
Thermoelectric Power Conversion	0.225	0.390	0.600
Battery Improvement Program	0.475	0.839	1.300
Dynamic Power Conversion	2.600	4.200	6.250
Sub-Total	4.975	9.759	13.238
TOTAL	8.913	14.644	20.172

Propulsion

(Continued from page 16)

• **Nuclear propulsion** — NASA is asking for nearly $104 million for nuclear propulsion, almost all of which would help support the Atomic Energy Commission/NASA nuclear rocket development program.

Initial goal is a series of flight tests in the 1966-67 period.

NASA reports that in Fiscal '63 the development and test of Kiwi reactors will have reached the point where the full nuclear-rocket-engine *(Nerva)* development program, involving procurement and testing of engine components, subsystems and complete systems, will be expanded. The major development effort leading to the flight-test-vehicle stage initiated will also be expanded.

NASA disclosed that in addition to the effort aimed at the 1966-67 flight tests, research, development and test of an advanced reactor design will be included in the AEC/NASA program.

Requested Fiscal '63 funding for advanced research in nuclear propulsion in millions of dollars, is:

Hydrogen properties, $0.8; radiation effects, $1.9; dynamics and control, $1.3; engine systems and components, $2.5; advanced concepts, $1.6.

For advanced technical development:

Reactor test support, $5.5; nuclear rocket-engine development, $36.0; system and component technology, $7.8; propellants, $12.5.

For flight programs:

SNAP-8 vehicle integration, $7.6; nuclear rocket flight-test stage development, $25.7; operational safety, $0.6. ⌘

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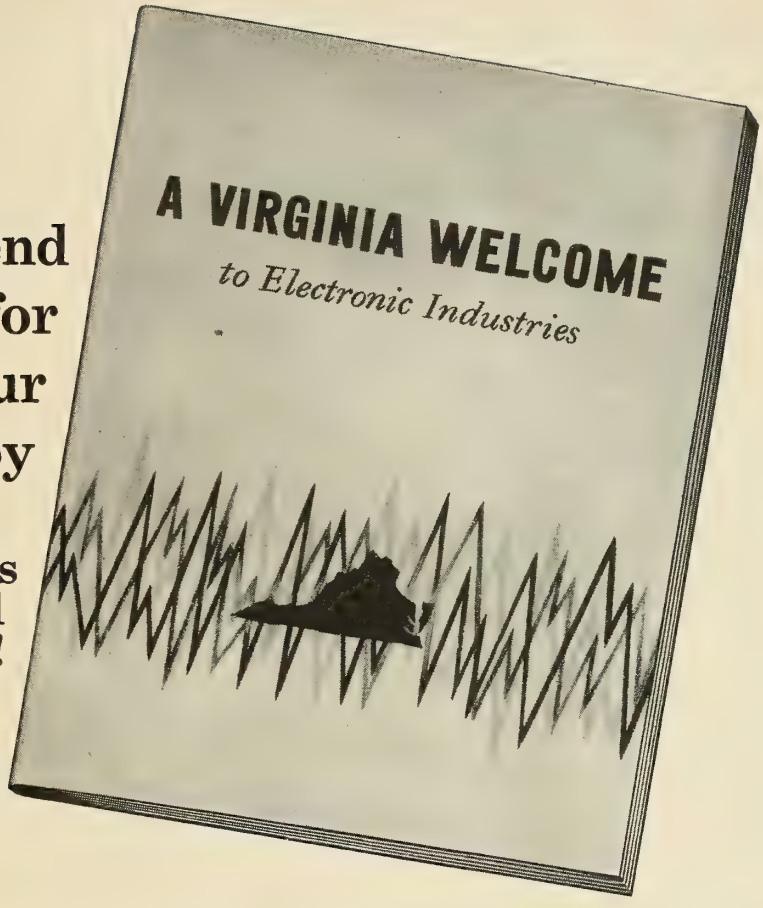

52 electronic companies have located in Virginia during the past 10 years. This new 30-page report gives facts about the experience of many of these companies, and presents maps, charts, statistical tables and short text on topics such as the following:

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The population and geographic characteristics of Virginia that provide such a wide range of site choices for electronic companies.

The federal military, space and other technical operations in the Washington, D. C. area, the Hampton Roads region and other areas that are in the forefront of the government's electronic programs.

The delivery time by truck from Virginia localities to major electronic markets, the air facilities available at Virginia communities, other transportation data.

Estimates of the number of persons available for new jobs annually and wage rates prevailing in the electronic industries.

Virginia's program of trade and technical courses in electronics.

Engineering graduates of Virginia colleges and universities, present college courses available for company personnel, faculty and equipment at these institutions for company research.

Record of labor-management harmony — salient features of Virginia's favorable government climate.

Recreational facilities in the State.

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At New York World's Fair . . .

'Aerospace Island'—Never-Never Land?

Rocket Society may take on sponsorship role rejected by AIA and big companies, but there are problems

by Michael Getler

NEW YORK—Officials in charge of the 1964 World's Fair here are finding it hard to get to their dream "Aerospace Island" without a paddle.

The paddle, in this case, is someone to run the show—an industrial group, individual firm, or technical society which will, in effect, turn the display into a technically integrated exhibit of the U.S. aerospace industry.

The search for a "sponsor" has gone on for almost a year, so far with many expressions of interest but no firm commitment. However, an end to the search may be in sight.

Last month, a personal letter from World's Fair Corp. President Robert Moses officially invited the American Rocket Society to consider undertaking the job of directing the show. The ARS Board of Governors was expected to take action on the request late last week during the three-day ARS Launch Vehicles Conference at Phoenix, Ariz.

Though many problems are involved—not the least of them the likelihood of an upcoming ARS merger with the Institute of the Aerospace Sciences—the Rocket Society hierarchy, in consultation with IAS officials, were expected to at least look into the feasibility of running such an immense project. The study, if undertaken, would turn up facts concerning industry support, staff needs, and financial backing.

If the "Aerospace Island" is ever to become a reality, a firm plan for the exhibit must come by mid-summer. The Fair opens in April, 1964, and runs, with the exception of winter adjournments, through October, 1965. According to the New York Port Authority, which is responsible for the "Transportation" sector of the Fair—the one in which it is hoped that the space exhibit will appear—about 70 million persons will visit the vast complex during the two years.

• **2-million ante**—A quarter-million square feet of prime Fair ground has been set aside for the display. This space will rent for $8 per sq. ft., bringing the cost of the project to at least $2 million before anyone even sets up shop. Fair officials estimate another $10 million will go into the actual pavilions.

Location of the more-than-5-acre space display is also considered to be one of the best. It is flanked by the two largest exhibits—a $35-million General Motors presentation and a $28-million Ford pavilion.

According to Port Authority officials, a good deal of planning has already gone into the aerospace project; however, the services of competent technical management are vital in order to create the authentic space display that is envisioned. There will be no ten-cent rocket rides for the kiddies, they point out.

• **Hot potato** — The search for someone to provide direction and management for the exhibit started last June, when Fair officials approached the Aerospace Industries Association, then considered to be the logical choice. While most member firms were reported to be heavily in favor of such a display, the AIA governing body felt that as an organization it could not run the project, since it might, in effect, impinge on rights of some member companies which might not wish to associate.

The ball which AIA dropped as a group was picked up by the Martin Company shortly afterward. Martin proposed a plan in which it would put up half the funds for a much smaller space display based on the *Apollo* program. This, of course, was before the competition had been decided in favor of North American Aviation. Martin had offered to contribute $1.5 million to the project, with each of five major team members chipping in $300,000 each.

North American, contacted by the Fair committee after award of *Apollo*, reportedly turned down the proposition.

In addition to the Martin Company (whose interest remains extremely high, according to Fair officials), other major support from the industrial quarter has come from Aerojet-General Corp. and United Aircraft Corp.

With a major industrial society (AIA) out of the picture, along with several individual companies who could not support a project of the type and size envisioned by World Fair planners, the committee then turned to the scientific community societies, and specifically to ARS because of its recent experience with the "Space Flight Report to the Nation" show and its reputation as a top professional group.

Whether or not ARS says "yes" remains to be seen. Favoring acceptance, however, is the fact that Dr. Edward C. Welsh, Executive Secretary of the National Aeronautics and Space Council, is understood to have sent a personal letter of confidence to the society.

The major obstacle that ARS faces is somewhat similar to that which turned away the AIA. That is, though there is considerable internal support from individual members is it within the realm of a professional technical society—and if so, is there enough support from industry to do the job correctly?

A further factor may be the IAS, which is alleged to have a somewhat more conservative approach to shows in general than does the ARS.

Despite these complexities, the current odds, according to informed sources, are that the ARS will take on the project.

The exhibit within the Transportation sector is certainly to be the largest concentrated presentation of aerospace effort. There will undoubtedly be small outcroppings of the business in other state and federal displays, but nothing on the order of the "Aerospace Island" plan. Though not yet firm, the U.S. Federal display is not expected to be devoted in any part to the space program, and Fair officials are expected to discuss participation in the main exhibit with both NASA and DOD. ⁂

Industry Trends and Forecasts

Ling-Temco-Vought, Inc., is investing some $10.5-to-$13 million in company-sponsored R&D this year, and even more for government contracts. President Gifford J. Johnson said "our determination to show a profit in each quarter of 1962 has not swayed our conviction that large, well-managed R&D programs provide the most sensible way to insure LTV's future." Most R&D, he said, is aimed beyond 1962 for products on which LTV will build its future. He said the investment "assures better earnings in the years ahead." . . . *Merck & Co., Inc., pharmaceutical and chemical firm, will spend $23 million on its 1962 scientific research program.* . . . Republic Aviation Corp. donated $25,000 for establishment of an Aeronautical Engineering Research Fund at Princeton University. The fund, to be augmented by gifts from other sources, will enable Princeton's Department of Aeronautical Engineering to continue studies of such problems as "screaming" in large rockets. . . . *California Gov. Edmund G. Brown asked the State Legislature to establish a Commission on Automation and Technological Developments to study the nature and amount of unemployment due to automation, skills required, retraining of workers and educational problems in relationship to automation, what industry is doing to meet the problem, and possile solutions. The proposed commission would be comprised of five industry members, five from labor, three from the general public, two Senators and two Assemblymen.* . . . Delta Airlines established a "Missile Express" jet service from California to the Orlando/Cape Canaveral area. . . . *Roger Lewis, new president of General Dynamics, has a five-year contract paying $125,000 a year. The figure was disclosed in GD's proxy statement, which also showed that if Lewis' full-time employment is terminated he will be paid $40,000 a year thereafter—to a maximum of 10 years—provided he continues as a consultant and for five years is not hired by a competitor.*

New Names in the Industry

Delta Electronics, Inc. has been formed in Alexandria, Va., to develop and custom fabricate specialized electronic equipment. President is Stephen W. Kershner. . . . *Northrop Corp changed the name of its Radioplane Div. to Northrop Corporation—Ventura Division.* . . . PM Electronics, Inc., changed its name to California Instruments Corp.

New Industry Facilities

The Boeing Co. will build a $2-million radiation laboratory at Seattle to validate results of company research in nuclear radiation. Completion is scheduled for early next year. . . . *General Electric Co. has taken option on land near Oklahoma City, Okla., for possible future expansion of missile, satellite and spacecraft development and manufacturing facilities. The company also leased space in Oklahoma City to make electronic guidance system components.* . . . Commercial Filters Corp. is building a 35,000-sq.-ft. addition to its Lebanon, Ind., plant. The new facility will enable the company to concentrate all metalworking operations in one location. . . . *The Garrett Corp. allocated $3 million for construction of an 87,000-sq.-ft. space facility and purchase of new machining equipment. The facility, at Torrance, Calif., will include a space lab capable of simulating a flight into space and to the moon. It is slated for completion in early 1963, and will be occupied by components involved in R&D of environmental control and cryogenic systems for space vehicles. The new lab will include 17 space chambers, two vibration rooms, two hot and cold chamber, a humidity chamber, a fungus chamber, two clean rooms, a data acquisition center and test benches.* . . . American Machine and Foundry Co. established the AMF instrument division in Alexandria, Va., for development and manufacture of precision electrical meters. The company also opened an environmental lab to analyze effects of environment on components for aerospace GSE and missile and aircraft operations. The latter facility is at Stamford, Conn., and is part of AMF's Government Products Group. . . . *General Kinetics Inc., Arlington, Va., formed a Production Div. to manufacture company-developed products.* . . . Crane Co.'s Hydro-Aire Div. added a $250,000 clean room to its Burbank, Calif., facilities for functional testing and final cleanup of hydraulic components. . . . *Infrared Industries, Inc., began construction of a $750,000 research and manufacturing facility at Santa Barbara, Calif. The building will provide manufacturing headquarters for the company's Simpson Optical Division.* . . . North American Asbestos Corp. opened a new plant at Mundelein, Ill., for production of Crocidolite and Amosite asbestos mat. . . . *General Precision Equipment Corp. will open a Research Center for Aerospace Sciences this year at Little Falls, N.J. GP says "The new research center will be devoted to basic materials research that can result in new products."*

News of Mergers and Acquisitions

Donaldson Co., Inc., Minneapolis, acquired Hydrodyne Corp., North Hollywood, Calif., manufacturer of precision products for the missile/space industry. . . . *Champion Spark Plug Co. acquired controlling interest in Cousino Electronics Corp., Toledo, Ohio, developer of automatic data processing and signal-relay equipment.* . . . General Precision Inc. purchased Royal Precision Corp., which will operate as the Data Processing Div. of GPI. . . . *United Nuclear Corp. and Sabre-Pinon Corp. stockholders have approved a merger, with UNC the surviving company. UNC is a producer of nuclear fuel materials, nuclear fuel elements and reactor cores. S-P holds interest in uranium mines and mills.*

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Solids Boosted

Report at SAE Meeting Cites Cost Advantage

NEW YORK—The economics of providing the U.S. with 6-12-million-lb.-thrust boost vehicles for the next 10 years of space exploration was discussed here last week at the Society of Automotive Engineers' National Aeronautics Meeting.

According to a study made for NASA by North American Aviation's Space and Information Systems Division, single-tank liquid-propellant vehicles enjoy a cost-per-pound-of-payload advantage over solid-fuel boosters for both escape and 300-mile orbital conditions.

The figures on liquid boosters for escape missions were listed as $173/lb.-of-payload, as opposed to $215 for conventional solids. For the 300-mile orbital role, liquid costs are estimated on the order of $65/lb.-of-payload against about $80 for the solids.

The advent of nuclear systems, the study shows, should provide great economic advantages for the escape mission, with payloads weights doubled at about half the cost of using liquids.

In addition to this whack at development of solids in this thrust category, a significant conclusion was that this range of boost power was totally feasible in several *Saturn*- and *Nova*-class configurations and did not appear to make any unrealistic economic demands on the overall space program.

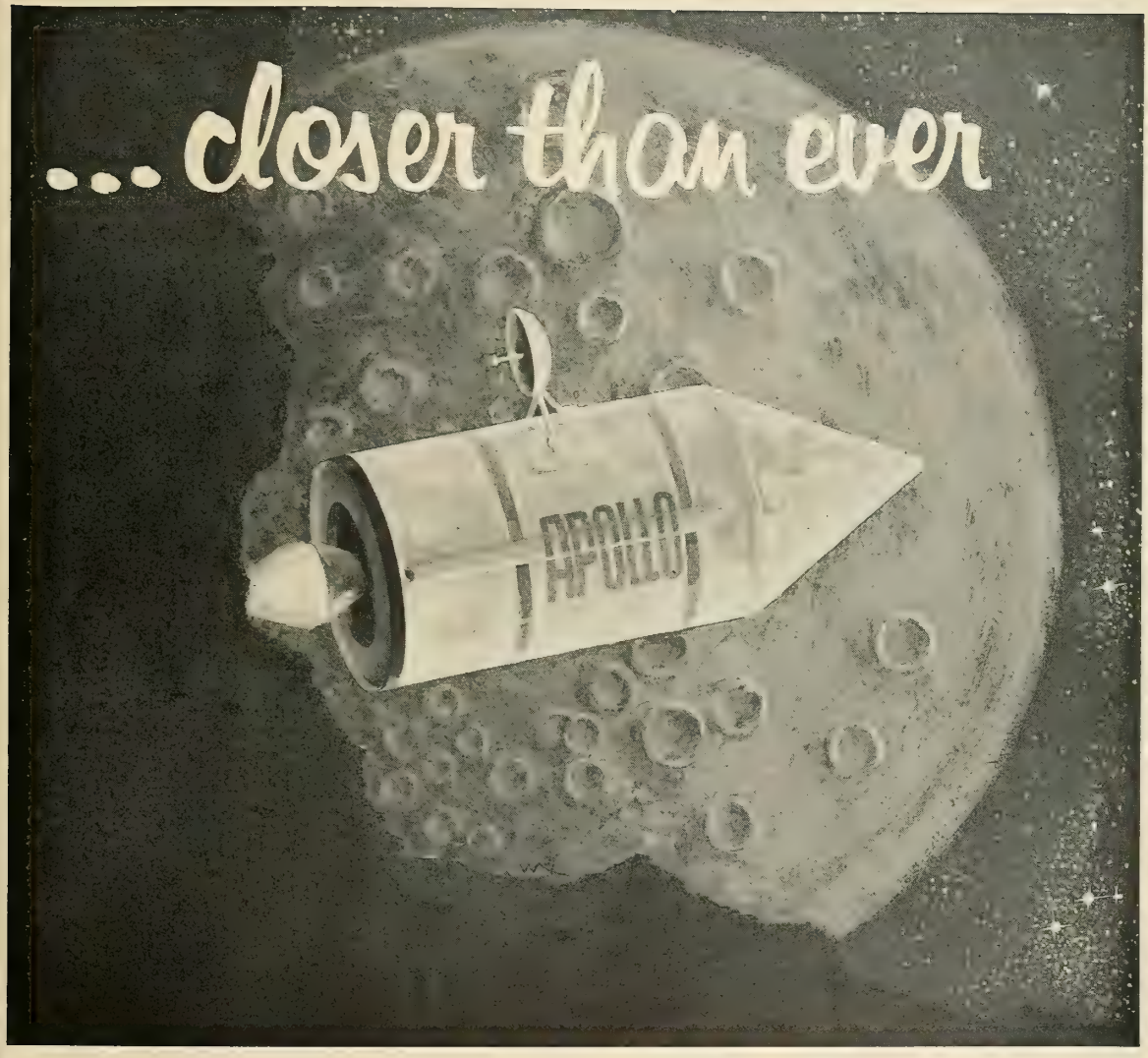
• **Direct vs. rendezvous** — The discussion of booster economies also carried into the argument between proponents of direct flight and orbital rendezvous techniques for lunar landing.

The study concluded that there are some economies to be gained by producing a large number of boosters of the *Saturn C-5* type and employing orbital rendezvous techniques. However, as payload increases, an economic tradeoff occurs with a direct-flight *Nova*-type vehicle due to payload reduction factors incurred by the addition of rendezvous guidance, propellants, and structures.

The study also points out that the reliability of the rendezvous method may be somewhat below the direct flight—also tending eventually to shift the economic balance.

For space missions contemplated for this decade, the authors say the *Saturn C-5* vehicle appears to have the required capability for both direct flight and orbital rendezvous approaches. The *Nova*-class vehicle with nuclear upper staging justified by both performance and economy appears to be the next major step beyond *Saturn*. ⌗

MANNED LUNAR LANDING



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names in the news

JONES

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POLING

HULL

TITTLE

Thomas V. Jones: President and chief executive officer of Northrop Corp., named to the board of directors of the Times-Mirror Co., Los Angeles. Other directors in the missile/space field who were re-elected are **Don G. Mitchell,** vice chairman of General Telephone & Electronics Corp. and **Charles B. Thornton,** chairman of Litton Industries, Inc.

John Lawrence: Made chairman and chief executive officer of Dresser Industries, Inc. **F. G. Fabian, Jr.** was elected president and **R. E. Reimer** was named chairman of the Finance Committee while continuing as treasurer.

W. E. Thomas: Member of the board of directors and executive vice president of the Magnaflux Corp., Chicago, promoted to president.

Allan C. Johnson: Has joined Aerojet-General Corp., Azusa, Calif., as assistant to the chairman of the board.

Gerald E. Donovan: Former director and vice president-finance of Douglas Aircraft Corp., is now a director of Crescent Engineering & Research Corp., El Monte, Calif.

Dr. Zvi Prihar: Appointed scientific advisor to the director of research and development at Page Communications Engineers, Inc., Washington, D.C.

Don S. Burrows: Former controller of the Atomic Energy Commission, has joined the Martin Co. Baltimore, in a newly created position in which he will function in an overall management and administration capacity.

Trevor Gardner and **Herbert F. York:** Members of the Board of trustees of Aerospace Corp., have been named to serve on the General Advisory Committee of the U.S. Arms Control and Disarmament Agency.

Howard C. Appleman: Formerly with Minneapolis-Honeywell Regulator Co., has joined the Little Falls Division of REDM Corp., Singac, N.J., as vice president and general manager.

Joseph M. Barr: Assigned to the Washington office of United Aircraft Corp., as vice president to coordinate activities of the company's divisions and subsidiaries. **James S. Lee** will succeed Barr as president of United Aircraft International.

F. Leonard Bryant: Reelected president of Hooker Chemical Corp., New York City, has also been designated chief executive officer.

Max Poling: Appointed vice president and director of marketing of California Magnetic Control Corp., North Hollywood, Calif.

Dr. Sanborn C. Brown and **Dr. David J. Rose:** Members of M.I.T.'s Physics and Nuclear Engineering Departments, respectively, have been elected to the board of directors of Magnion, Inc., Cambridge, Mass. **Dr. David R. Whitehouse,** also of M.I.T., was appointed chairman of Magnion's technical advisory board.

Seymour Cuker: Will fill the new position of vice president for research at Astronetic Research, Inc., Nashua, N.H.

Capt. David R. Hull (USN-Ret.): Has been elected to the board of directors of the Astronautics Corp. of America, Milwaukee.

William H. Simmet, Richard E. Nearman and **Wendell C. Swenson:** Promoted to fill newly-created vice presidencies of Washington Technological Associates, Inc., Washington, D.C. Simmet will act in the capacity of vice-president, marketing; Nearman as vice president, engineering; and Swenson as vice president, comptroller.

Howard K. Schoenwetter: Made vice president of engineering at General Devices, Inc., Princeton, N.J.

Dr. Charles H. Townes: Awarded the National Academy of Sciences John J. Carty Medal for his pioneering work in the development of the maser.

H. C. Tittle: Appointed vice president-operations planning of Sylvania Electronics Systems, a division of Sylvania Electric Products, Inc., Needham, Mass. Tittle will be replaced in his former position of vice president and general manager of the division's central operation in Buffalo, N.Y. by **E. J. Vigneron.**

Gerald E. Donovan: Elected to the board of directors of Crescent Engineering & Research Co., El Monte, Calif.

Carlyle A. Mounteer: Appointed vice president and general manager; **Howard A. Nielsen,** vice president and marketing manager; and **Joseph C. Sanchez,** vice president and engineering manager, of Micro Systems, Inc., San Gabriel, Calif.

Dr. Elmer W. Engstrom: President of the Radio Corp. of America, named by the Electronic Industries Association board of directors to receive the Association's highest award, the EIA Medal of Honor, for distinguished service contributing to the advancement of the electronics industry.

A. W. McEwan: Will head the electron tube laboratories of ITT Components Division, International Telephone and Telegraph Corp., as director. **John J. Graham,** vice president, will be head of the U.S. Commercial Group of ITT, and **Glenn W. Bailey** has been appointed president of Royal Electric Corp., Pawtucket, R.I., a subsidiary of ITT.

Dr. Edwin Naumann: Named director of systems development for Northrop Space Laboratories.

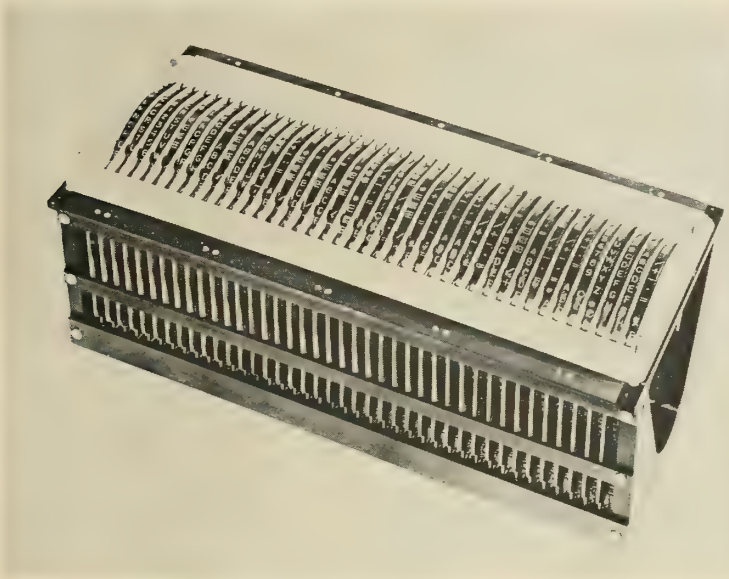
Thomas E. Vail: Elected vice president of National Astro Laboratories, Inc., Pasadena, Calif.

Robert W. Falconer: Named manager of Aerospace Corporation's Pacific Missile Range Office at Vandenberg AFB, Calif.

John A. Morgan: Appointed corporate general manager of Special Devices, Inc., Newhall, Calif.

Jack B. Dear: Promoted to vice president and manager of sales of The Duraloy Company, Scottdale, Pa.

Herbert J. Hall: Returns to Research-Cottrell, Inc., Bound Brook, N.J., in the capacity of director of research.



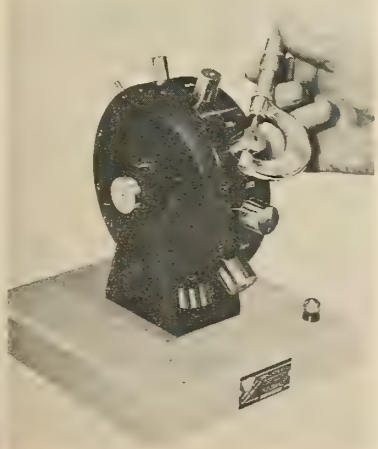
New Product of the Week: Data Switch Assembly

A HIGH-CAPACITY data switch composed of extremely thin subassemblies is now being manufactured by Instrument Systems Corp. Each subassembly is a single-pole 54-position device rated for 0.3 ampere at 150 volts into a non-inductive load. Actual length occupied by 12 of the switches is less than five inches. The fixed switch contacts are formed by printed-circuit techniques on an epoxy-glass base material of high physical stability. A rigid aluminum drum rotates on a hub fastened to the printed-circuit card. Switch position markings are engraved on the outer periphery of this drum. Alongside the engravings is a thin knurled edge to permit manual drum-indexing by thumb.

Circle No. 225 on Subscriber Service Card

Precision Cylinders

A compact "Ferris wheel" system of precision cylinders for checking the accuracy and condition of micrometers is available from Size Control Co., Div. of American Gage & Machine Co., The unit makes it possible for the first time to analyze major micrometer defects (precision, lead error of micrometer screw, and anvil parallelism) with a single device.



Circle No. 226 on Subscriber Service Card

Low-Pressure Transducer

Edcliff Instruments is producing a miniature, low-pressure transducer. The Model 2-51 is only one cubic inch in size and weighs less than three ounces. It has high reliability and accuracy and withstands 100-g shock without damage. Its output is linear with pressure. The pressure media is isolated from electrical components and ranges are from 0 to 5 up to 500 psi.

Circle No. 227 on Subscriber Service Card

Hydrophone Amplifier

An ultra-low-noise hydrophone amplifier, described as a "major advance" in underwater acoustical detection, has been introduced by the underwater systems laboratory of ACF Electronics, a division of ACF Industries.

The amplifier is intended for use specifically with piezoelectric ceramic hydrophones exhibiting a capacitive source impedance. It is suited to applications in which small hydrophones having low sensitivity and low capacitance are used.

Circle No. 228 on Subscriber Service Card

Microwave Receiver

Sylvania Electronic System's RC-10 microwave receiver, constructed to MIL specifications, is provided with three electronic tuning modes (panoramic, sector and manual) over 0.5 to 18 gc in six bands. Designed for use in crowded pulse-signal environments, it employs a 100-db gating circuit to help reject strong interfering signals—even when on the same frequency as a desired weak signal.

Other advantages reported are: recovery from any blocking signal within 5 microseconds; provision of AFC and AGC; panoramic sweep of entire band on upper trace of a two-gun CRT; ability to switch the lower trace to a triggered A-scan, to allow examination of individual pulses or pulse groups.

Circle No. 229 on Subscriber Service Card

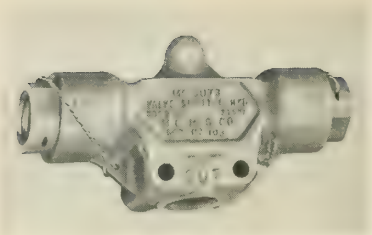
Solid-State Gated Counter

Model 3001, a solid-state, gated counter particularly suited to meter-proving and high-speed gated counting, is being marketed by Erie-Pacific, Div. of Erie Resistor Corp. It features in-line Nixie readout in 4, 5 or 6 decades. Specifications include: Frequency Range: 10-100KC, 0-100,000 pps; Accuracy ±1 Count; Start and Stop Inputs: external switch closure—momentary or long duration; Reset: pushbutton on front panel; Power: 115/230V ±10%, 50/60 cps, 30 watts.

Circle No. 230 on Subscriber Service Card

Shuttle Valve

M. C. Manufacturing Co., has announced development of a high-pressure shuttle valve which meets the requirements of MIL-V-19068A (ASG) and drawing MS28767 (ASG). The



valve is designed for use with either hydraulic fluid (MIL-H-5606) or dry air at operating pressures up to 3000 psi throughout a temperature range of −65°F to +275°F. Shuttling occurs when the pressure at one IN port exceeds the pressure at the other IN port by 25 to 100 psi; reverse flow will not unseat the poppet.

Circle No. 231 on Subscriber Service Card

Analog/Digital Converter

A high-speed analog-to-digital converter is available from Raytheon Co., Communications and Data Processing Operation. It operates at up to 500,000 complete 10-bit conversions per second. Output is either serial or parallel straight binary on all units. Serial output is 5 million bits per second while parallel output is up to 500,000 words per second.

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Circle No. 9 on Subscriber Service Card

new literature

THE OSBORN MFG. CO. BRUSHES —An eight-page bulletin describing the operating characteristics and giving complete installation data on Osborn Mfg. Company's Rota-Master brush line, has been published. Bulletin 365-3 reviews and illustrates the advantages of the new Rota-Master's lightweight, self-cleaning construction.

The new units, designed to clean conveyors, and remove build-up of such materials as chemicals, core sand, ore and other bulk materials, are available in 6-in. and 10¾-in. diameters. Four pages of the text are devoted to installation data, including motor requirements, wiring, shaft and bearings, brush location, brush rotational speeds, and brush wear adjustment. Full-page sketches show mounting techniques and header pulley arrangements.

Circle No. 200 on Subscriber Service Card

CONTROL PANELS AND SYSTEMS —Bulletin CSD-1000, published by the Control Systems Div. of Fostoria Corp., describes control panels and systems now available for automatic control of processes and operations in all areas of industrial activity. It pictures and describes panel installations that feature mechanical relays and contactors, as well as static logic elements and other solid-state devices. Included is a listing of various devices commonly used in control systems.

Circle No. 201 on Subscriber Service Card

DOUBLE DISC GRINDING—A bulletin offered by Precision Disc Grinding Corp. describes advantages of double disc grinding over fly cutting, face turning, surface grinding and face grinding. Outlined are how double disc grinding works, materials that can be ground, etc.

Circle No. 202 on Subscriber Service Card

HARD CARBIDES — Chemical and processing industry applications of hard carbides are illustrated by nearly 50 kinds of equipment components in a new 28-page booklet (No. B-550) compiled by Kennametal Inc. Components are divided into five classes of equipment: seals and valves, nozzles and whizzers, handling and processing, atomic and aerospace products, and ultrahigh pressure. Nobility and endurance of carbides are shown by their high corrosion resistance, oxidation resistance up to 1100°F and above, and wear resistance up to 100 times that of steel. High impact resistance, rigidity of two to three times that of hardened steel, and dimensional stability are also valued.

Circle No. 203 on Subscriber Service Card

contracts

AIR FORCE

$23,149,970—General Dynamics Corp., San Diego, for *Atlas* boosters and for design, fabrication and delivery of *Atlas* missiles (2 contracts).

$17,703,940—Martin Marietta Corp., Denver, for work as integrating contractor for activation of *Titan* operational bases at Ellsworth, Mountain Home, Larson and Beale AFB's, for production of modification kits and related material for modifying *Titan* trainers, for spare parts and related material for the *Titan II* missile, and for fabrication and installation of *Titan II* operational ground equipment (4 contracts).

$16,169,000—The Boeing Co., Seattle, for R&D of the *Minuteman* ICBM system including missiles, flight test and development of support equipment and an engineering test program (2 contracts).

$10,235,000 — Douglas Aircraft Co., Santa Monica, Calif., for R&D of the *Skybolt* ALBM and for ground support for the *Skybolt* (2 contracts).

$7,813,000—American Machine & Foundry Co., Greenwich, Conn., for work on the *Titan I* launcher system.

$6,100,000—Mitre Corp., Bedford, Mass., for electronic systems, engineering and technical development.

$5,500,000—Page Communications Engineers, Inc., Washington, **River Construction Corp.,** Ft. Worth, **and Curran & Co.,** Great Falls, Mont., for construction of the installation and checkout system of a cable communications network for the *Minuteman* site at Ellsworth AFB, S.D. (joint venture).

$4,019,250—Western Electric Co., New York, for production and installation of ground communications and associated systems at Vandenberg AFB and Point Arguello, Calif.

$3,083,000—North American Aviation, Inc., Canoga Park, Calif., for *Atlas* booster engines and for engineering support for the *Atlas* weapon system during 1962.

$2,850,000—Lockheed Aircraft Corp., Burbank, Calif., for R&D of a satellite control subsystem.

$2,668,000—American Bosch Arma Corp., Garden City, N.Y., for R&D on the *Titan* missile guidance system.

$2,490,000—Aerojet-General Corp., Sacramento, Calif., for experimental work to obtain engineering data for design of a large liquid-propellant rocket engine.

$2,341,233—North American Aviation, Inc., Downey, Calif., for spares for the *Minuteman* guidance and control system and for work on *Hound Dog* missile system (2 contracts).

$2,306,124—General Motors Corp., Milwaukee, for depot maintenance of the *Thor* all-inertial guidance subsytem and associated equipment (2 contracts).

$2,005,740—Revere Copper and Brass, Inc., Brooklyn, for production of chaff for passive defense against airborne weapons systems.

$2,000,000—General Precision, Inc., GPL division, Pleasantville, N.Y., for aerospace flight and test equipment.

$2,000,000—General Electric Co., Syracuse, for systems management and integration for an air weapons control system.

$1,645,845—Philco Corp., Western Development Laboratories, Palo Alto, Calif., for production of a satellite control network.

$1,400,000—Hercules Powder Co., Wilmington, for R&D of Stage III *Minuteman* motors.

$1,293,000—American Bosch Arma Corp., Garden City, N.Y., for missile guidance sets and related items.

$1,000,000—International Telephone and Telegraph Corp., Chicago, for modification and additions to existing space program communications systems at Vandenberg AFB, Calif.

$292,500—Collins Radio Co., Cedar Rapids, Iowa, for single sideband equipment for missile programs.

ARMY

$30,546,293—Western Electric Co., New York, for R&D on the *Nike-Zeus* and *Zeus* multi-function array radar, for *Nike-Hercules* guidance system components, and for repair parts for radar equipment for *Nike-Hercules* (3 contracts).

$5,742,326—Raytheon Co., Lexington, Mass., for field maintenance test equipment and components and parts for the *Hawk* missile system (2 contracts).

$5,200,000—Sperry Utah Co., Salt Lake City, for continued production of *Sergeant* missiles.

$3,570,068—Ford Motor Co., Aeronutronic Division, Newport Beach, Calif., for the *Shillelagh* missile.

$3,274,665—Douglas Aircraft Co., Inc., Santa Monica, for 235 *Nike-Hercules* missile air frames.

$3,000,000—Martin Marietta Corp., Orlando, Fla., for modification of the *Pershing* missile system.

$1,921,000—Pacific General Construction Co., Inc., Seattle, for construction of three *Nike-Hercules* Hipar systems at Fort Richardson, Alaska.

$1,165,861—Curtiss-Wright Corp., Wright Aeronautical division, Wood Ridge, N.J., for rocket motor cases for the *Pershing* missile.

INDUSTRY

$1,000,000—Clauser Technology Corp., Torrance, Calif., **from Hughes Aircraft Co.,** for design, fabrication and installation of a large space simulation chamber.

$900,000—Electronic Associates, Inc., Long Branch, N.J., **from Vitro-Selenia Spa.,** Italy, to supply missile range instrumentation for the Salto di Quirra Range on Sardinia.

$800,000—Cubic Corp., San Diego, **from Lockheed,** for tracking systems for locating and recovering satellites in the Pacific.

$500,000—United Control Corp., Redmond, Wash., **from the Boeing Co.,** for temperature control equipment for the *Minuteman* ICBM.

$135,000—Hoover Co., Electronics division, Baltimore, **from Boeing,** for electronic test equipment for the *Minuteman* program.

$100,000—Leach Corp., Compton, Calif., **from Lockheed Missiles and Space Co.,** for magnetic tape recorder systems to use in the *Polaris* testing program.

NAVY

$12,190,000—Hercules Powder Co., Wilmington, Del., for continued research and development on solid propellants.

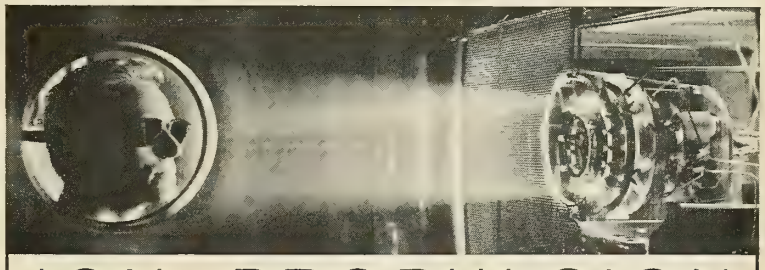
$4,994,654—General Precision Co., Glendale, Calif., for fire control system components for *Asroc* antisubmarine rocket.

$4,750,000—Ryan Aeronautical Co., San Diego, for augumentation and ground support equipment and spares for *Q-2C Firebee* drones.

NASA

$5,000,000—Republic Aviation Corp., Farmingdale, L.I., N.Y., for Project *Fire* flight re-entry research program.

$149,619—Thompson Ramo Wooldridge, Inc., Space Technology Laboratories, Inc., Redondo Beach Calif., for program to advance the state of the art in valve technology for space applications.



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reviews

OPTIMUM DESIGN OF MECHANICAL ELEMENTS, Ray C. Johnson, John Wiley & Sons, New York 16, N. Y., 535 pp., $11.50.

The author takes a more academic approach than do most writers of books on machine design. It is, however, a refreshing approach: Johnson considers that there is more than one answer to a design problem, and he concentrates on trying to get the best one. Thus, despite the somewhat stilted tone of the book, it can be immensely useful to the mechanical engineer who must be certain that he is getting optimum design. He will even be relieved of the tedium of using a cut-and-try method. An understanding of elementary calculus will take most engineers through the book. They will be amply rewarded if their work calls for designing machine elements or mechanisms.

SATELLITE ENVIRONMENT HANDBOOK, edited by Francis S. Johnson, Stanford University Press, Stanford, Calif., 155 pp., $5.50.

Here is an excellent text that belongs in the library of every engineer and space scientist concerned with sending probes and craft above the earth's atmosphere. It provides answers to questions about the upper atmosphere that ordinarily would be obtained only after many hours of library research. The information was compiled chiefly in response to engineering questions directed to the Space Physics Research organization at Lockheed Missiles and Space Co.

The data which describe the geophysical environment encountered by earth satellites are presented in a comprehensive summary—the structure of the upper atmosphere and the ionosphere, penetrating-particle radiation, solar radiation, micrometeorites, radio noise, thermal radiation from earth, and geomagnetism. Johnson is Lockheed's manager of Space Physics Research. Contributors in addition to Johnson are A. J. Dessler, O. K. Garriott, W. B. Hanson, and J. F. Vedder.

INTRODUCTION TO HYPERSONIC FLOW, G. G. Chernyi, Moscow State University, translated and edited by Ronald F. Probstein, Brown University. Academic Press, New York. 262 pp., $6.

This translation of a recently published Soviet text provides an introduction to the fundamentals of inviscid hypersonic flow theory and to the most important methods of calculating ideal gas flows at hypersonic speeds.

Included are many topics, such as flows past slender blunted bodies, to which Soviet aerodynamicists have made major contributions and which are not found discussed in detail in Western books on the subject.

Explanatory notes have been added, and the text has been revised and edited with the full cooperation of the author.

An extensive reference list of almost two hundred Soviet and Western publications is made useful by the inclusion of references to English translations for most of the Russian works.

when and where

APRIL

American Institute of Electrical Engineers, Rubber and Plastic Industries Conference, Sheraton Hotel, Akron, April 9-10.

Instrument Society of America, National Chemical and Petroleum Instrumentation Symposium, Wilmington, Del., April 9-10.

Thirty-third Annual Scientific Meeting of Aerospace Medical Association, Chalfonte-Haddon Hall, Atlantic City, N.J., April 9-12.

American Society of Mechanical Engineers, Metals Engineering Conference, Sheraton-Cleveland Hotel, Cleveland, April 9-13.

Spring National Convention, Society of Nondestructive Testing, Pick-Carter Hotel, Cleveland, April 9-13.

Southwest Conference and Electronics Show, sponsored by IRE, Rice Hotel, Houston, April 11-13.

Regional Technical Conference, Society of Plastics Engineers, University of Rochester, N.Y., April 12.

Conference on Refractory Metals, American Institute of Mining, Metallurgical, and Petroleum Engineers, Morrison Hotel, Chicago, April 12-13.

American Physical Society, Plasma Physics Symposium, Hilton Inn, Tarrytown, N.Y., April 13-14.

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LeMay Takes a Stand

GEN. CURTIS E. LEMAY, bulldog-jawed Air Force chief of staff, has not been conspicuous publicly—except by his absence—in the fight for a bigger military space role.

Although the general has, in the past, expressed his belief in the need for a mixed bag of aircraft and spacecraft, he never has come out strongly for the Air Force space role, leaving that to lesser lights.

His stubborn fight with Secretary of Defense Robert McNamara over the B-70, in fact, caused us some concern. The Air Force has more important things to fight for these days. LeMay's stand created considerable ill-will in DOD and on the Hill.

It is with some pleasure, therefore, that we have read the text of the speech delivered by Gen. LeMay at Assumption College in Worcester, Mass., on March 28.

In that speech, the AF Chief of Staff takes his strongest stand to date in favor of an extensive military space capability.

"Military space capabilities will eventually be the choice made by our political process," Gen. LeMay said. "What we should do is to expedite the process by recognizing the advantages of developing military space systems as quickly as possible."

To prevent a fatal technological surprise in the 1970's, the general declared, U.S. defense preparations must provide military capabilities in space, including both unmanned and manned spacecraft.

Dr. Robert H. Goddard's pioneer work in rocketry was recognized in Russia as early as 1920, LeMay pointed out. By 1929 the first of nine volumes of an encyclopedia on space travel was published in the Soviet Union. In 1934 the first Soviet liquid-propellant rocket was successfully fired. In 1937 the Soviet Union established rocket test centers at Kazan, Moscow and Leningrad.

AT THE SAME TIME, LeMay noted, the U.S. failed to recognize the significance of Goddard's work. Although Goddard successfully demonstrated rocket engine performance many times, and technical reports on his work were widely published by the Smithsonian Institution, there was little official interest.

In fact, a representative of the Army Air Corps who visited Goddard in 1936 to assess his work reported that it had little military value.

"We can't afford to make that kind of mistake today," Gen. LeMay warned.

We now face the problem of choosing what to do about the development of capabilities in space, the general pointed out. There is technical argument, economic argument and philosophical argument about this political choice.

"Not too many years go," the Air Force chief said, "the public was accustomed to the idea that the Defense Department would provide for our external security. The job of keeping America secure was the military's, under the direction of the President and with appropriations voted by the Congress.

"Today a new phenomenon has tended to dissociate this public image of security from the Defense Department. This phenomenon fogs the vision. It outmodes classical ways to deal with security problems. And it confuses our efforts to develop a workable national military strategy."

WHAT HAS HAPPENED, the general said, is that many people have come to believe that action by the armed forces will result in the destruction of this nation as well as that of the aggressor.

"Most people recoil from the idea of building military space capabilities because they see this as a further cause for instability and a needless extension of a nuclear arms race that, in their view, has already gone too far," LeMay said. "When you lump their arguments together with those of the very logical and calm fellow who asks why try to deter nuclear war by taking the nuclear weapon into space —since we can already do an impressive job with it from here on Earth—when you get the total effect of these arguments, then you have a lot of tough opposition to military space systems."

There is one point which these people miss, LeMay said: they look on space operations merely as an extension of the use of nuclear weapons.

"This may not be the case at all," he declared.

Future space armament may, instead, include exotic weapons capable of neutralizing earth-based ICBM's, beam-directed energy weapons which strike with the speed of light.

"That kind of speed makes the 15,000-mile-an-hour ICBM a relatively slow-moving target," he pointed out. The general noted that both the U.S. and the Soviet Union have been investigating such weapons.

Suppose the Soviets were first to develop these? he asked. They could neutralize our ICBM's, satellites and spacecraft, and prevent us from developing an equal defense.

"They could even prevent us from going into space for peaceful purposes," Gen. LeMay warned. It was a telling point in an excellent, literate and most welcome speech.

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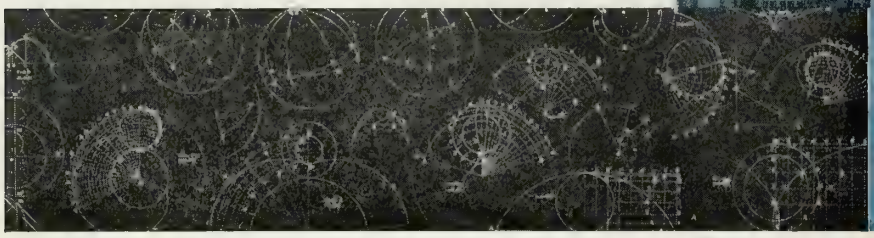
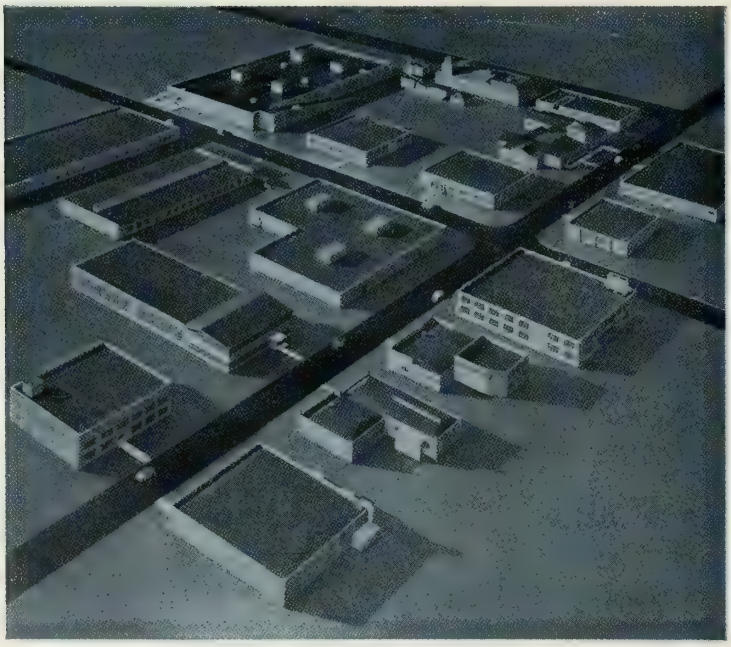


computers that pace man's expanding mind



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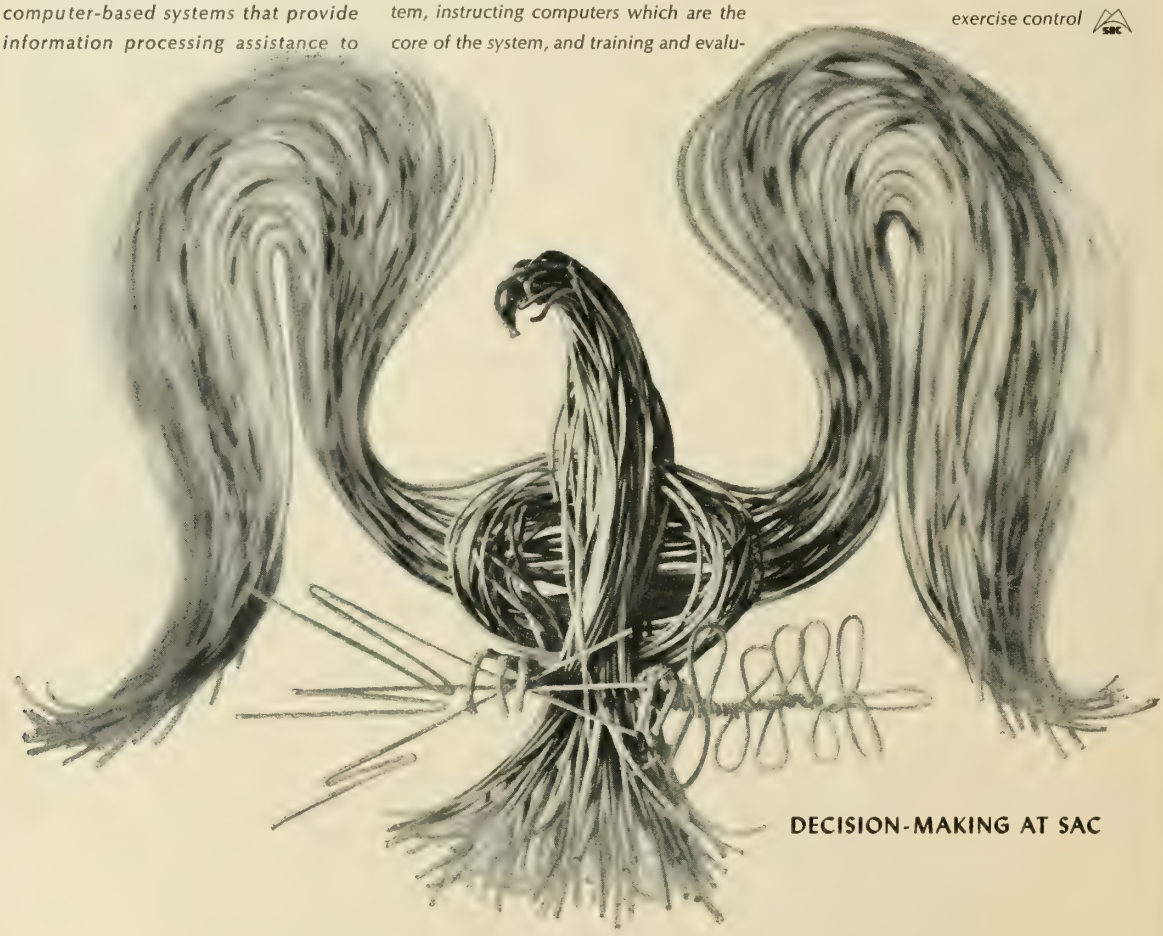

DECISION-MAKING AT SAC

THE WEEKLY OF SPACE SYSTEMS ENGINEERING

missiles and rockets

Volume 10, Number 16 April 16, 1962

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THE COVER

Although not visible, 204 attentuated glass filaments are being drawn from glowing bushings in a test run at Owens-Corning Fiberglas. This is first step toward filament-wound solid rocket cases. *See p. 24.*

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letters

Greek Rocket Group

To the Editor:

We wish to inform you that the Scientific Rocket Research Group on Space has recently been established by a group of scientists and technicians of our country, aiming at carrying out research in Greece, too, on high-altitude solid-fueled rockets and on space.

As we are keenly interested in cooperation with scientific research institutions, scientific research sections of various companies, and scientists of your country engaged in rocketry and space, we would like to ask you to help us by announcing in the columns of your leading magazine (to which the undersigned is a subscriber) the establishment of our group, and mentioning the address, so that interested persons may write to us.

Apostolos Frangos, B.A.
Scientific Rockets Research Group on Space
43, Ellanikou Str., Pangrati
Athens, Greece

Interest in India

To the Editor:

I shall be deeply grateful if my name is included in the list of editors and others who have the honour to receive a copy of your esteemed publication.

Your publication is the foremost on the subject in the world and will, as such, be an indispensable source and reference material in this organization.

Jaswant Singh
Editor
India Armed Forces Year Book
Bombay, India

Who's An Engineer?

To the Editor:

I have read the numerous letters to the editor which have appeared subsequent to your article on the engineering shortage. Most of these letters, which are obviously written by non-graduates, fail to touch my heart. In fact, I am a little tired of listening to the woes of the non-graduate who so readily passes himself off as an "engineer."

The graduate engineer is in somewhat of a quandry himself. He is attempting to raise the engineering profession to the standards of a true profession. In the majority of cases, the non-graduate is lending nothing to this endeavor.

If these non-graduates are as capable as they profess to be, they should be able to receive a degree in an absolute minimum of time. I believe that there are many recognized universities which will award full credit for a particular course if one merely passes a form of 'Final" examination which demonstrates proficiency in that subject.

The graduate engineer will continue to have difficulty in attempting to be recognized as a true professional as long as the present multitude of non-graduates in industry continue to lower the status of the profession by classifying themselves as "engineers." Industry, in general, could be criticized for affixing too encompassing a definition to this classification.

There is definitely a place for the non-graduate in industry. However, let's not be so hasty as to label everyone as an engineer.

T. J. Nawrocki
Cocoa Beach, Fla.

'Too Old' at 40?

To the Editor:

In answer to the "too old" question (in connection with the controversial shortage of engineers):

May I call attention to John Glenn's age—he is *40!* Not a "hot shot" 25-30 or even 35.

W. C. Davis
(who is 55 and a physical scientist, AOMC-Redstone Arsenal, and not on a per diem)
Huntsville, Ala.

The Lights of Perth—I

In silence have the moon and stars looked down
Since time began, uncomprehendingly.
And not 'til now our still Australian town
Had dared to beam its friendship skyward. We
Shall greet the living star with tongues of light,
With streets ablaze and houses bright as day,
While he is drowned in deep and dreadful night,
Unseen yet seeing, borne upon his way
In solitude. The fearful void between
His place and ours cannot be spanned by sound;
Yet haply will our shining speech be seen
And understood. Community has found
A luminescent voice, to speak with worth
And splendor, in the friendly lights of Perth.

J. P. Davis
Nuclear Engineer
Burns & Roe, Inc.
New York

Circle No. 6 on Subscriber Service Card

Go East, Old Man

To the Editor:

In the Feb. 26 M/R, an article entitled "MA-6 Speeds Spaceflight Plans" reports that Lt. Col. Glenn travelled around the world from West to East in 4 hrs. 56 min. 26 sec., leaving at 9:47 a.m. and returning at 2:43 p.m. the same day.

Now then, may I pose a question: Since our age is based on the fact that the Earth revolves around the Sun in approximately 365¼ days—which we call a year—and that the Earth rotates on its axis in approximately 24 hours—which we call a day—could we say that since Col. Glenn travelled around the Earth three times on the same day he is now approximately three days younger (not considering the exact mathematical calculations involved)?

Paul J. Malie
Cumberland, Md.

It Was an Aerobee

To the Editor:

I enjoyed the article on sounding rockets (M/R, April 2, p. 36). However, the picture accompanying the article is an *Aerobee 150A*, not an *Iris*. Various models of the *Aerobee* have been flown since 1947, and the model shown in the photo can carry a 100-lb. payload to 175 miles altitude or a 300-lb. load to 100 miles altitude.

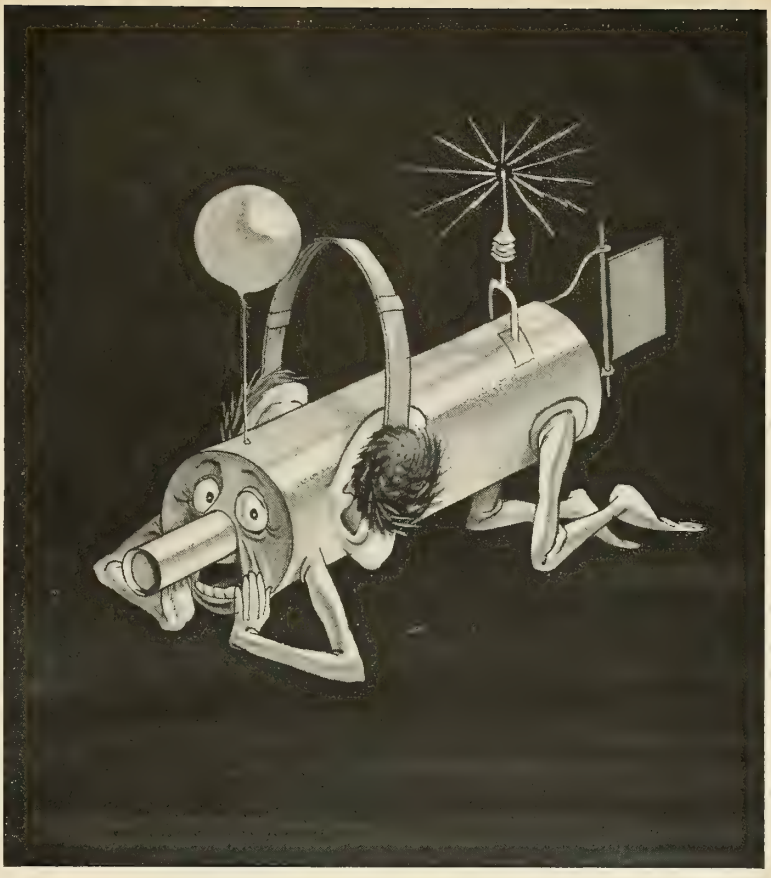
NASA plans to launch some 40 *Aerobee* vehicles during the forthcoming year from the Wallops Island, Va., facility and the Navy facility at White Sands, N.M.

AEROBEE, not Iris.

An interesting feature of the *Aerobee*, noticeable in the photograph, is that both the liquid sustainer and solid booster are thrusting as the vehicles leaves the tower.

Jon R. Busse
Aerobee Vehicle Manager
Goddard Space Flight Center
NASA
Greenbelt, Md.

The photo in question was supplied by NASA and bore a caption identifying the sounding rocket as an Atlantic Research Corp. Iris. M/R should, however, have spotted it as an Aerobee by its two sets of fins.—Ed.



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The state-of-the art of telemetry reception has advanced another step with the new Nems-Clarke Solid State Preamplifiers.

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SPECIFICATIONS

SSP-136
Pass Band 134-138mc
Noise Figure . . . . . 4db max.

SSP-101
Pass Band 225-260mc
Noise Figure . . . . . 4.5db max.

Common to both units
Uniformity of Response . . . Within 3db
Gain . . . . . 25db minimum
Output Imp. Operates in 50 ohm system
Power Requirements. 12 v. dc at 12 ma
Weight . . . . . 19 ounces
Size . . . . . Diameter 2½", length 6½"

Circle No. 7 on Subscriber Service Card

The term "Military Command Technology" may be new to you. However it stands for a principle that is as old as war itself — the ability to detect attack and retaliate.

Today this ability requires big and complex electronic systems. Their domain is the earth, the atmosphere around it, the infinite reaches of space. The concept behind them encompasses this nation's overall military strategy — present and anticipated. It includes all levels of civilian and military decision making. It provides for war plans, communications, intelligence, control of all forces, deployment of sensors, surveillance of space, logistics, support operations, and survival.

The design and development of such systems is the basic work of MITRE. SAGE, MIDAS, NORAD Combat Operations Center, BMEWS are among the many inter-related, constantly evolving systems. More challenging systems are being planned.

MITRE is made up of scientists and engineers who are responsible for some of the most important work now being done in the electronic systems field. There is room for more such men in the three major groups of the corporation — Systems Planning and Research; Systems Engineering, and Control and Sensor Systems Development.

MITRE is located in pleasant suburban Boston. Openings are also available in Washington, D. C. and Colorado Springs. Minimum requirements, B.S., or M.S., or Ph.D. Rewards are competitive. If you are interested in playing an important part in MITRE's work for national defense — in advancing this new science with an old purpose, Military Command Technology — you are invited to write, in confidence, to Vice President — Technical Operations, The MITRE Corporation, Box 208, Dept. **WF12**, Bedford, Mass.

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The Countdown

WASHINGTON

Skepticism Over RS-70 Missile

Although concern over RS-70 development problems has been directed publicly to the data-gathering and display systems, Department of Defense also has serious reservations about development of a suitable stand-off missile for the aircraft. According to DOD officials, the missiles would have to be carried internally and would have a shorter range than *Skybolt*. A new propulsion and guidance system also would have to be developed.

NASA Solid Booster Details

New NASA solid booster for flight qualification of *Apollo* spacecraft modules and systems (M/R, April 9, p. 9) will have a thrust of 250,000 lbs. *Redstone* pad No. 5 at Cape Canaveral will be modified to accommodate the new booster.

PMR Constellation Monitors Satellites

Signals from a number of orbiting satellites were monitored by a Pacific Missile Range WV-2 Lockheed Constellation during a globe-circling flight eastward from PMR. During the flight, the aircraft's 20-man crew replaced one Atlantic Missile Range ship for the *MA-6* orbit performing a stand-by mission over the Indian Ocean during the Glenn flight. The aircraft normally is assigned to frequency interference control operations for PMR.

Air Force Bioastronautic Spending

Aerospace Medical Division of AF Systems Command will have spent a budget of $15 million by June 30—just seven months after its conception. This does not include a $6.3-million construction program at home base, Brooks AFB, San Antonio, Tex. Nor does it include the Air Force share of 39% of NASA's space medicine budget which goes to DOD this year. By comparison, NASA's FY 1962 space medicine budget totals $17,244,000.

NASA Tries Out New Incentive Contract

NASA is experimenting with a new type of cost incentive contract based on overhead. Currently, one such contract has been awarded. If it works, more will follow.

Russians Ignore Samos Classification

How effective is the Pentagon's new classification of the *Samos* spy satellite system? In an article in Moscow's *Red Star* on March 18, Lt. Col. V. Larionov—identified as a "candidate of military sciences"—writes that for the reconnaissance of land targets, the U.S. plans "to launch into orbit 20 experimental models of the *Samos* system and in the following years an additional eight satellites a year."

Pershing Has Its Problems

Despite the successful launch program, Martin's solid-fueled *Pershing* missile is having its share of difficulties. The Army, in fact, has scheduled four specially-instrumented missiles to try to verify computer explanations of the problem. The first was fired last week (see M/S Week). Difficulties appear to be centered in the warhead section of the missile—particularly during re-entry.

Initial Gemini Flight Is Slipping

First flight of NASA's Project *Gemini* two-man spaceflight series may slip into 1964. Reason: time required for construction of launch facilities. NASA estimates modification of launch pad 19 for the *Titan II* booster will take 20 months. This would make it available too late for *Gemini's* 1963 launches.

INDUSTRY

Apollo Guidance Contracts Due

Industrial contracts for the *Apollo* spacecraft guidance and control system are to be awarded by NASA within six weeks. Three firms are to share in the work initially. Others may be added later.

Civil Defense Rocket Contract Awarded

A pyrotechnic rocket is under design and development by Rocket Power, Inc., of Mesa, Ariz., for use as a supplemental outdoor warning signal in event of impending nuclear attack. The rocket would be positioned on power lines and be triggered by an electrical impulse transmitted through the lines. Contract was awarded by the Office of Civil Defense.

More F-1 Stands for Edwards AFB

Three more F-1 engine test stands will be built at Edwards AFB for NASA acceptance tests. Stands will have single-engine capability and will use a common blockhouse. Completion is slated for late next year.

New PMR Launch Complex for Spacecraft

Two new launch sites at the Pacific Missile Range Point Arguello, Calif., facility are to go operational this month in support of PMR spacecraft operations. One is the first to be built for NASA at PMR. It will be used in the *Scout* program to launch various payloads into orbit for NASA, AF and Navy programs. The other site, under Navy management control, is a multi-purpose launch complex capable of handling high-altitude probe-type vehicles with up to 150,000 lbs. thrust. The two use a common control center.

INTERNATIONAL

ELDO Gets Go-Ahead from Members

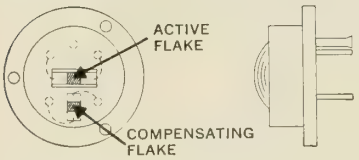
The European Launcher Development Organization is now in business. Sufficient member states—including Britain, France, West Germany and Italy—have signed the intergovernmental convention. Australia, Belgium and the Netherlands are expected to follow. European industry is welcoming ELDO as a means of getting a space program under way, but expects it to go out of business in a few years as its functions are taken over by Eurospace, the cartel of European missile, electronics and engineering firms.

European Space Symposium Set

A three-day symposium on exploration of near-space is being organized by the Société Française d'Astronautique in conjunction with the British Interplanetary Society. It will be held at UNESCO Palais, Avenue de Suffren, Paris 7, from June 18-20. Requests for information should be forwarded to the Société Française d'Astronautique, 94 Boulevard Hausemann, Paris (8e), France.

SERVO IR Report

Wide Range of Standards In Thermistor Bolometers



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The Missile/Space Week

Centaur, S-51 Shots Delayed

Technical difficulties forced NASA to postpone a heralded "space double-header" scheduled for last week.

The first launch of *Centaur* was scrubbed on April 11 because of fuel pressurization problems in the *Atlas* first stage. Officials said a delay of at least 24 hours would be required and further slippage was possible.

The launch of the *S-51* U.S.-British satellite was also postponed on April 10 because of a launch vehicle malfunction.

No new launch date has been set, but a delay of two weeks was forecast by the space agency.

Shots of the Week

A terse AF announcement from Point Arguello, Calif., confirmed the successful launching April 9 of an *Atlas-Agena B* carrying a classified satellite package.

However, AF officials not only refused to disclose whether the satellite was a *Midas* or *Samos* reconnaissance satellite, but also would not say if the *Agena* vehicle had gone into orbit.

Among the components aboard the satellite vehicle was an unclassified proton damage experiment to measure space radiation effects.

In other firings:

• An *Atlas F* ICBM blew up on its pad at Cape Canaveral, April 9, causing heavy damage within its launch area and delaying the missile test program about six weeks until repairs are effected.

The missile—heavily instrumented to obtain data on previous test difficulties—exploded just as the countdown reached zero. Cause of the explosion was not immediately available.

Due to the tapering off of the *Atlas* test program, the extensively damaged pad was the only one of four built for the *Atlas* program still being used for that purpose. The others have been assigned to other programs.

• The Army successfully fired a *Pershing* missile from Cape Canaveral April 4, to gather data on the re-entry conditions of the missile's warhead.

Following a short-range trajectory in order to simulate severe climatic conditions at liftoff, the missile impacted in a pre-selected target area in the Atlantic Ocean.

The *Pershing* was fired from its mobile transporter-erector-launcher. However, the Army stressed that the test was not conducted "under fully tactical conditions."

• A *Nike-Zeus* successfully intercepted a simulated ICBM warhead over White Sands Missile Range, N.M., April 5, "well within the lethal radius" of the operational *Zeus* warhead, according to an Army announcement.

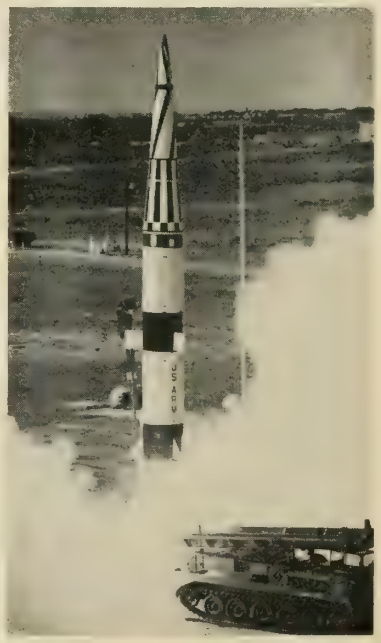
• The *X-15* on April 5 made the third in a new series of flights to evaluate its Minneapolis-Honeywell adaptive control system.

A prototype for a similar system to be used in the *Dyna-Soar* vehicle, the M-H system was used throughout the flight, including landing.

Piloted by NASA's Neil Armstrong, the *X-15* reached an altitude of 179,000 ft. and a maximum speed of 2830 mph.

• Russia on April 6 launched its second satellite vehicle in three weeks, according to an announcement by Tass.

Called *Cosmos II*, the satellite was launched into a highly elliptical



Latest Pershing Flight

ARMY'S Martin Pershing is fired from its transporter-erector-launcher in successful short-range shot on April 4.

orbit—apogee: 975 miles; perigee: 133 miles; period: 102.5 min.

The objectives of the *Cosmos II*, according to Tass, were to check and improve elements of space vehicle construction and scientific investigations of the environment of outer space.

Thiokol Wins Apollo Award

The solid-propellant tower jettison motor for NASA's *Apollo* spacecraft will be designed and built by Thiokol Chemical Corp.'s Elkton Div., the Company announced last week.

The more-than-$1-million contract was awarded to Thiokol by North American Aviation Space and Information Systems Div. — prime contractor for the *Apollo* command module.

AFSC Forms Research Division

A Research and Technology Division (Provisional) has been established by Air Force Systems Command to plan and manage the Command's basic and applied research and advanced technology programs.

The new division, according to AFSC officials, will provide the plans, policies and procedures to be followed by the Command laboratories. It will also coordinate the research and technology program with the development and weapon systems activities within AFSC.

"The creation of this new division," according to AFSC spokesmen, "is in direct support of the expressed desires of the Secretary of Defense to strengthen the laboratory structure and to improve the in-house technical capabilities of the Armed Services."

The Research and Technology Division will be commanded by Colonel Joseph M. Silk, currently Deputy Chief of Staff for Research and Technology at AFSC. The Division will be initially housed at AFSC headquarters, Andrews AFB, Washington, D.C.

New Saturn Pad Going Up

Construction will begin this month at Cape Canaveral on the second launch pad for NASA's *Saturn C-1* booster.

A $4,540,000 construction contract for the new pad was recently awarded to the Blount Brothers Construction Co. of Montgomery, Ala.

Work under the new contract will include construction of a 233-ft.-high umbilical tower, a launch pedestal, automatic ground control building, fuel storage and handling facilities and extension of tracks for the mobile 3500-ton steel service tower.

The contract also calls for necessary site utilities and other improvements to be made by the Montgomery firm.

Work on the second pad is scheduled to be completed by June, 1963. Many items of construction are set for completion at earlier dates.

The giant *Saturn* rocket will be used to launch heavy payloads into space and to test the *Apollo* spacecraft, which will carry three men to the moon on the *Advanced Saturn* vehicle.

TFX Missile Development Pushed

Both the Air Force and the Navy are continuing development of a missile to be carried by the TFX (F-111) aircraft—although eventually the designs of the individual services will be combined into a single missile system.

Navy R&D efforts center around adapting the cancelled *Eagle* missile program to the greater performance demands of the TFX aircraft. Proposals for the development of a test missile for performance evaluation are expected imminently from four companies — Bendix, Grumman, Hughes and Raytheon.

The Air Force program is expected to be a growth version of the *Falcon* family of air-to-air missiles. The AF version will probably be based on the *Falcon GAR-9*, designed to carry a nuclear warhead.

Both services are pursuing programs to insure a missile responsive to their individual missions. The decision on the ultimate missile to be produced will not be made for at least a year, about the same time that the earliest TFX flying prototypes are available.

New Rules for Non-Profits

The long-awaited Budget Bureau study of non-profit organizations working for the government is expected to be finished within two weeks.

The report—first due last December, then deferred to March—is expected to call for a general "stiffening" of the rules covering non-profit corporations.

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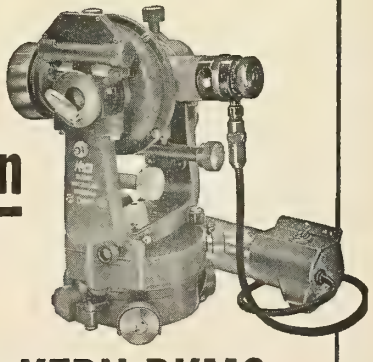

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In early House action . . .

NASA Budget Escapes Big Cuts

by Hal Taylor

STRONG SUPPORT of the Administration's space program is expected to continue this week as NASA's budget request of $3.7 billion for Fiscal 1963 moves to the House Space Committee.

Subcommittees voted to cut only some $120 million from NASA's authorization bill. Little, if any, further change is expected in the full committee, according to Congressional sources.

Action by the committee is expected within a few days.

The cut is minor when compared to the space agency's total funding request. Specific programs, however, felt the sharp edge of the Congressional knife.

• **Some slashes**—NASA's funding requests for manned spaceflight were slashed by $85 million. Most of this—about $50 million—will come out of the *Nova* booster program. Construction of facilities for the large launch vehicle was hardest hit by the subcommittee action.

Details of the remaining $25 million cut in Projects *Mercury, Gemini* and *Apollo* were not disclosed, but one Congressman said they were also centered in new facility construction.

The subcommittees on scientific satellites and lunar and interplanetary spacecraft voted to cut $32 million from the funds request for those programs. It rejected completely NASA's $10.4-million request for authority to go ahead with the *Prospector* spacecraft series.

The subcommittees' report asked that NASA establish a list of priorities to determine which satellite programs would feel the effects of the remaining $22-million reduction.

It was also learned that the subcommittee considering the authorization requests for tracking and data acquisition programs had approved a slight cut. Specific details were not disclosed, but one member said the cut of about $10 million would mainly affect new construction.

Two major NASA programs, the Office of Applications and the Office of Advanced Research and Technology, escaped unscathed. The subcommittee considering their funding requests voted unanimously for complete approval.

• **Prospector indecision** — NASA officials refused to comment on the subcommittee's action in withholding approval for the *Prospector* program. The spacecraft was originally planned to land anywhere on the moon and travel across the lunar surface during exploration missions.

Later, however, NASA changed the *Prospector* mission, deciding it would be better utilized as a supply vehicle to support a manned lunar landing.

NASA also had not decided whether *Prospector* would be managed by the Lunar and Planetary Spacecraft Office or the Office of Manned Space Flight.

The space agency's indecision contributed greatly to the subcommittee's action. One member declared that the subcommittee could not authorize a program when NASA still had not decided just what it was to be.

Subcommittee members also felt that the *Prospector* mission could be filled by simply adding a few more experiments to the *Surveyor* lunar soft-landing spacecraft. Such action, they said, would eventually save $200 million.

The full committee's report will emphasize that if NASA feels its programs will be hurt by the reductions, it can submit a supplemental Fiscal '63 request later.

Mercury 7 a Month Away

AMERICA'S second manned orbital spaceflight is now tentatively scheduled for the last two weeks in May.

Checkout for the Mercury capsule for the MA-7 flight has just about been completed at Cape Canaveral, according to NASA officials. It is expected to be mated to its Atlas booster in a couple of weeks.

If normal launch pad checkout procedures are followed, slippage of the launch date into June is possible.

The late launch date means that three months will have passed since the first U.S. manned orbital space flight with astronaut John Glenn at the controls. This will leave only time for perhaps one more three-orbit mission before Project Mercury's 18-orbit flight series starts early next year.

Four such three-orbit flights, including MA-7, were planned by NASA. If the next flight—with astronaut Malcolm S. Carpenter—is successful, the space agency may decide to drop the remainder.

• **Reefs ahead**—While the subcommittees' consideration was comparatively favorable, larger reductions lie ahead.

Once final space committee action is taken, the bill will then move to the House floor, where more heated opposition is expected. MISSILES AND ROCKETS learned that during consideration of the manned space flight budget, two members of the subcommittee called for a funds slash of $200 million.

This opposition may again crop up during the floor debate. Added to it will be traditional conservative approach of Republican and southern Democratic members of the House.

Once the authorization bill—which merely gives NASA permission to engage in certain programs—is approved by Congress, the House Appropriations Committee will decide just how much of the authorized funds should be appropriated for NASA use.

• **Friendly Senate**—The same congressional path must be taken by both the authorization and the appropriation bills in the Senate. Traditionally, however, the Senate is far more lenient in money matters than the House.

This was sharply illustrated late last week, as the Senate Appropriations Committee voted to approve all of NASA's supplementary Fiscal 1962 request for $85 million for research and development and $71 million for new construction.

Earlier, the House Appropriations Committee approved only $80 million of the R&D request—and balked completely at the construction budget because legislation authorizing it had not yet been approved.

Members of the House committee said they did not oppose the construction funds, and that approval would be given as soon as authorization was obtained.

With $5 million separating the two houses of Congress in the R&D request, it is expected that a conference committee will split the difference with appropriations of $82.5 million being approved.

The original $85 million request called for $50 million for the *Advanced Saturn*, $9 million for *Centaur* and $26 million for the M-1 liquid hydrogen-liquid oxygen engine. It will be up to NASA to decide which programs will feel the sting of any reduction. ⁂

Douglas Winds Up Its Testimony on Profit Margins

Firm gives no further explanation of figures involved in Nike launcher-loader contract; Western Electric to appear

DOUGLAS AIRCRAFT CO. executives, after three days of disputing McClellan committee figures on their *Nike* profit margin, last week quietly acquiesced in the accuracy of the committee's data, promised to submit recommendations for improving military procedures, and went home.

"We have no question of the integrity and motives of the committee," company president Donald W. Douglas told Sen. John L. McClellan (D-Ark.), chairman of the Senate Permanent Investigations Subcommittee.

"We appreciate this opportunity to help the committee in its investigation," Douglas added.

Left unanswered by the unexpected exodus of Douglas officials were figures introduced in the previous day's testimony by Thomas E. Nunnally, of the Government Accounting Office, purporting to show that Douglas had received a fee of $1,211,771 on a single contract for *Nike* launcher-loaders, while performing only $3316 worth of work on the contract.

Douglas told the committee after Nunnally's testimony that the figures could be explained, and he asked for an opportunity to do so. However, on the final day of his appearance the company president made no effort at an explanation—noting only that the particular contract in question was a fixed-price incentive award.

In winding up his testimony, Douglas blamed himself for the dispute with the committee, explaining that he worried about the overall state of the business and, therefore, felt that the real strength of the business as reported to the stockholders should be made public.

THE CHIEF of NASA's manned lunar landing program has assured Congress that the space agency is keeping tight control over contracting procedures to avoid "profit pyramiding" in the Apollo program.

NASA is "very careful to see what percentage (the prime contractors) are subcontracting and what percentage they contribute," D. Brainerd Holmes told the Manned Space Flight Authorization subcommittee of the House Space Committee.

NASA's philosophy in this area, Holmes said, is to make sure that prime contractors subcontract "only to the extent that it appears to be more efficient to have the prime do the integration."

• **Semantic struggle**—The principal point of contention between the company and the Senate committee was whether the $63.8 million that Douglas had made on 17 *Nike* contracts over the course of eight years was "profit" or "fee."

Douglas contended that the total sum represented a fee from which the company had to deduct expenses of running a business of $34.01 million—leaving a real profit of only $29.8 million.

Included in the business expenses were: interest—$3.59 million; specific development projects—$24.93 million; advertising—$2.14 million; amortization of emergency facilities—$1.3 million; and miscellaneous—$2.05 million.

In defense of the $63.8 million figure, however, Douglas told the committee that he felt that it was "reasonable," and must be viewed in light of the total $888.93 million work done by the company on the *Nike* program.

The committee, on the other hand, contended that the $63.8 million received from the government was, in fact, profit on the *Nike* programs. Admitting that for income tax purposes the fee would be reduced to cover the business expenses, McClellan argued that, as far as the contracts were concerned, the fee was profit.

"You had the money in the bank," he said, "and you didn't have to spend it on any of these things" (referring to the $34.01 million items).

• **Moving on**—McClellan expected to continue the hearings with appearances by Army officials connected with the *Nike* procurement program and also representatives of the prime contractor, Western Electric.

The hearings will then move on, probably this week, to the fees taken by contractors on the *Bomarc* and *Atlas* programs.

Meanwhile, H. I. Romnes, president of Western Electric, told a stockholders meeting in New York that the company did not profiteer on the work of subcontractors. He charged that the Senate investigators were guilty of statistical manipulation.

"We did not anticipate that sound and traditional business practice would be characterized as profiteering on the work of others," Romnes said. The company reportedly received fees of $169.5 million for its *Nike* work—$53.2 million of which, said the committee, was profit on subcontracted work.

However, Romnes said, "no part of (the profits) is profit taken for the work of others. Every cent we earned ourselves by what we did." ⌘

DOD Order Intensifies Secrecy on Space Launches

A NEW POLICY on Defense Department space projects will virtually eliminate all official information on this segment of the nation's space effort.

The ban prohibits use of popular names for spacecraft—such as *Midas, Samos,* and *Discoverer*. It also classifies identification of military payloads.

The new policy forbids advance announcement and press coverage of military space launches at Cape Canaveral, Point Arguello and Vandenberg AFB.

The text of the order, according to a DOD spokesman, is classified Top Secret. It was published, without announcement, by Deputy Defense Secretary Roswell Gilpatric on March 23.

The action was taken, officials said, for "national security purposes."

• **Opposition**—The change in policy had been rumored in the Pentagon for some time (M/R, Feb. 26, p. 9). Sources close to drafting of the change said it was inspired by the White House, and reflects a belief that much published news about space projects benefits only the Russians.

The effectiveness of the ban is questioned by some Pentagon officials; others consider it excessive. Among the latter is the DDR&E head, Dr. Harold Brown, who told a House Appropriations subcommittee recently that, as far as space programs are concerned, "there is a tendency to overclassify Department of Defense activities." ⌘

If Congress approves . . .

NASA Construction Goal: $3 Billion

Annual request for several years due to reach $800 million; big items launch complexes, test stands

NASA's buildup for the Manned Lunar Landing Program will push its construction costs to a rate of about $800 million annually for the next several years.

"I expect the construction budget will approximate NASA's Fiscal '63 request of $818 million for three or four years," Col. Thomas J. Hays III, director of the Army Corps of Engineers NASA-support office, told MISSILES AND ROCKETS.

This would push the total construction cost of the space agency's buildup to well over $3 billion. The total price-tag, however, hinges on congressional approval and no change in NASA's current estimated facilities requirements.

Col. Hays, who directs most of the new construction work, said the biggest items will be the launch complexes at Cape Canaveral and vehicle test stands at the Mississippi Test Facility.

His estimate was backed up by testimony of NASA officials before the House Space Committee.

The officials set the cost of the *Advanced Saturn* and *Nova* launch complexes at Cape Canaveral at about $700 million.

Support buildings and other minor construction will bring the total to about $1 million.

Test stands in the 7.5-million and 12-million-lb.-thrust class at the Mississippi facility were estimated to cost $300 million. Hundreds of millions of dollars more will be required for the eventual construction of test stands for large solid boosters with thrusts up to 22 million lbs.

The space agency officials also disclosed that new projects—currently in the planning stage—will help to skyrocket construction costs.

New manufacturing facilities for the first and second stage of the giant *Nova* liquid booster will be required. Design and engineering of the buildings —capable of turning out eight complete vehicles per year—will cost $16 million in Fiscal '63.

Whether or not the *Nova* facility can be built on land available at the Michoud, La., launch vehicle plant still has not been decided. If not, another Gulf Coast area will be selected.

Other new projects include Project *Apollo* control and recovery centers, Space Radiation Effects Laboratory, new facilities for the M-1 engine program and an *Advanced Saturn* dynamic test facility.

The big downpayment on NASA's construction needs will be made in Fiscal '63. The $818.9 million total includes $359.6 million at the Atlantic Missile Range; $92.5 million, Mississippi Test Facility; $14.4 million, Ames Research Center; $1.8 million, Flight Research Center; $23.8 million, Goddard Space Flight Center; $10.3 million, Jet Propulsion Laboratory; $8 million, Langley Research Center; $43.8 million, Lewis Research Center; $30.8 million, Manned Spacecraft Center; $33.4 million, Marshall Space Flight Center;

National Aeronautics and Space Administration
Construction of Facilities-1963 Programs

AMES RESEARCH CENTER

Bioscience laboratory	*0.92*
Mach number 50 helium tunnel	*1.5*
Radiative heat system for mass transfer facility	*2.2*
Space flight guidance research facility	*9.8*
Total	**14.4**

ATLANTIC MISSILE RANGE

Modifications to Saturn launch complex No. 34	*3.8*
Modifications to Saturn launch complex No. 37	*1.1*
Modifications to provide a launch complex for solid suborbital vehicles	*1.7*
Supporting facilities	*3.0*
Addition to assembly facility for unmanned spacecraft	*2.0*
Explosive safe assembly facilities for unmanned spacecraft	*0.45*
Apollo mission support facilities	*22.5*
Modifications to Titan II launch complex	*2.4*
Utility installations	*0.8*
Advanced Saturn Launch Complex No. 39	*176.5*
Advanced Saturn-Nova supporting facilities	*39.1*
Apollo static test facility	*5.0*
Nova launch complex	*79.5*
Utility installations	*22*
Facility planning and design	*10*
Total	**359.9**

FLIGHT RESEARCH CENTER

Building Additions	*1.3*
Visual flight simulator	*0.5*
Total	**1.8**

GODDARD SPACE FLIGHT CENTER

Applied Sciences laboratory	*3.2*
Attitude test control facility	*0.9*
Conversion of dynamic test chamber	*3.2*
Development operations facility	*1.8*
Launch phase simulator	*3.9*
Spacecraft operations facility	*7.5*
Tracking and telemetry laboratory	*3.2*
Total	**23.8**

JET PROPULSION LABORATORY

Addition to fabrication services building	*0.6*
Data operations and command facility	*2.4*
Engineering mechanics building	*0.3*
Additions to materials research laboratory	*0.6*
Telecommunications laboratory	*2.9*
Utility installations	*0.8*
Total	**10.4**

LANGLEY RESEARCH CENTER

Heating plant addition	*0.86*
MHD research equipment	*1.5*
10-megawatt arc tunnel	*0.76*
Environmental research facilities	*0.98*
Micrometeoroid particle accelerator	*0.93*
Stabilization & control equipment lab.	*1.4*
Vehicle antenna test facility	*1.7*
Total	**8.1**

LEWIS RESEARCH CENTER

Development engineering bldg.	*4.7*

$18.4 million, Michoud Plant; $40 million, Nuclear Rocket Development Station; $4.3 million, Wallops Station; and $127.3 million, at various locations.

Fiscal '63 budget requests for other major construction projects (in millions of dollars) follow:

• **Atlantic Missile Range**—The *Advanced Saturn* launch complex No. 39 is funded at $176.5. NASA estimates that this will cover 40% of its total cost. This will include site development and utility installations, $4.0; Vertical Assembly and Checkout building, $92.8; rail transfer system, $8.4; launch pad, $5.6; equipment instrumentation and support systems, $48.8; design and engineering services, $16.8.

The vertical assembly building is budgeted at $40.6; design and engineering services, $13.1; and site development and utility installations, $5.7.

• **Mississippi Test Facility**—Fiscal '63 funds will be used to construct one static test position and start construction of a second test position for the *Advanced Saturn*. The $36-million funding is about 40% of the estimated cost. It includes site development and utility installation, $1.1; 1st test stand, $6.0; 1st test stand deflector, $1.5; 2nd test stand foundation, $1.1; control center, $1.6; observation bunkers, $.02; water storage tanks, $1.0; propellant storage tanks, $2.0; gas storage tanks, $2.0; recording instrumentation, $3.0; analog and digital systems, $4.0; vehicle adaption hardware, $2.4; high-pressure water pumps and distribution system, $3.8; propellant transfer system, $1.6; high-pressure gas transfer system, $1.0.

The *Nova* stage test facilities are funded at $43.0 million, which is estimated to be 25% of the total cost. It includes (in millions), site development and utility installation, $1.2; first stage test stand, $18.1; first-stage test stand deflector, $1.8; second-stage test stand, $4.9; observation bunkers, $.04; recording instrumentation, $4.3; analog to digital system, $4.2; control systems, $3.6; propellant systems, $3.0; and design and engineering services, $8.5.

• **Manned Spacecraft Center**—Total $30.8 million, including $10.6 million for a flight acceleration facility in which a high-g centrifuge will be used to simulate a large number of variables and conditions which will be encountered in actual manned space flight. Other large items (in millions), are thermochemical test facilities, $6.0; lunar landing simulation facility, $6.5; site development and utility installations, $7.6.

• **Lewis Research Center**—Total $43.8 million, with the major item, $25.5 million for the space propulsion facility. This will permit the evaluation and development testing of complete advanced power generation and electric propulsion systems. The cost (in millions) includes site development and utility installations, $2.0; facility construction, $7.1; equipment instrumentation and support systems, $14.2; and design and engineering, $2.1.

Other construction items at Lewis (in millions) are development and engineering building, $4.6; hydrogen heat transfer building, $2.4; lunar propulsion research facility, $6.2; modernization and reconditioning of Plum Brook service facilities, $1.5 and nuclear rocket dynamics and controls facility, $3.5.

(Details of each NASA center's construction budget are included in the accompanying chart.)

Spherical Motor Tested

SPHERICAL solid rocket motor, 17 in. in diameter and loaded with 140 lbs. of BFG high-performance fuel was static-fired for 45 sec. at B. F. Goodrich Rialto plant. Navy-developed motor is said to have "certain (undefined) advanced capabilities."

LEWIS RESEARCH CENTER

Hydrogen heat transfer facility	2.4
Lunar propulsion research facility	6.3
Plum Brook modernization	1.5
Nuclear rocket dynamics facility	3.5
Space propulsion facility	25.5
Total	**43.8**

MANNED SPACECRAFT CENTER

Flight acceleration facility	10.6
Thermochemical test facilities	6.0
Lunar landing simulation facility	6.5
Site development and utility installations	7.6
Total	**30.8**

MARSHALL SPACE FLIGHT CENTER

Computation division addition	1.3
Components test facility	4.0
Components and subassembly acceptance building	0.9
Engineering and administration building	2.5
Expansion of instrumentation systems in west area	4.0
F-1 engine test stand	4.5
Hydraulic test facility	0.3
Low-temperature facility	0.6
Modification of west side of static test stand	2.0
Engineering building	1.0
Instrument lab.	2.0
Support facilities in west area	7.8
Utility installations	2.5
Total	**33.4**

MICHOUD PLANT

Modification to Michoud plant	11.4
High-pressure test facility	1.0
Hydrostatic test and cleaning facility	3.0
Vertical assembly building	3.0
Total	**18.4**

MISSISSIPPI TEST FACILITY

Advanced Saturn stage test facilities	36.0
Nova stage facilities	43.0
Utility installations and support facilities	13.5
Total	**92.5**

NUCLEAR ROCKET DEVELOPMENT STATION

Stage static test and maintenance	20.2
Stage demating, maintenance and disassembly facilities	8.6
Radiation effects facility	7.1
Components test facilities	1.9
Support facilities	2.1
Total	**40.0**

VARIOUS LOCATIONS

Advanced antenna system, Goldstone	14.2
Advanced Saturn dynamic test facility	2.1
Antenna facility, Johannesburg	5.0
Antenna facility, Woomera	5.0
Data acquisition, Far East	6.0
Data acquisition, Rosman	3.5
F-1 engine facilities	25.0
J-2 engine facilities	4.0
M-1 engine facilities	16.0
Manned space flight control centers	18.0
Space radiation effects lab	12.4
Nova stage manufacturing facilities	16.1
Total	**127.3**

WALLOPS STATION

Advanced data acquisition	1.5
Range control modification and expansion	2.0
Vehicle checkout facilities	0.8
Total	**4.3**
Total 1963 Program	**819**

In Fiscal '63 budget . . .

NASA Farms Out More Space Medicine

SOME 93% of NASA's aerospace medicine budget for 1963 will be spent outside the NASA laboratories and centers.

Brig. Gen. Charles H. Roadman, director of aerospace medicine in NASA's Office of Manned Spaceflight, said in Congressional testimony last week that 35% of the agency's space medicine money is earmarked for Department of Defense laboratories.

Industry will get 30% of the $19,320,000 NASA is asking for, and other government agencies will get 20%. Of this, all but one-half of one percent will go to the Atomic Energy Commission for radiation studies.

Another 5% will go to support research in universities and non-profit organizations, and the remaining 7% will be kept by NASA for management, test, and integration of the equipment developed into spacecraft systems.

The new budget plans show an increased trend towards placing NASA funds in outside agencies. In FY 1962, about 85% is going outside NASA, although DOD is getting as much as 39% of the total budget for aerospace medicine.

• **Radiation prime concern** — As Roadman pointed out before the House Committee on Science and Astronautics, radiation is a critical factor this year because the design of *Gemini* and *Apollo* spacecraft must be frozen at relatively early dates.

The $1.6-million increase in radiation protection funding is a major factor in the total budget increase from $17,244,000 in FY '62 to $19,320,000 requested for '63.

Roadman said that the *Gemini* earth-orbit rendezvous mission may encounter a radiation problem in the event of a highly elliptical orbit. But for *Apollo,* he added, it represents a major danger.

An especially urgent requirement, he noted, is that a laboratory study be initiated to determine the effects of the interactions of all the kinds of radiation which may be encountered in the *Apollo* mission.

Roadman also called for the determination of the effects of protons on living tissue. He pointed out that most of the previous AEC work dealt with neutrons, since neutrons and gamma rays are the principal radiations from nuclear weapon detonations. However, protons are the principal particles found in solar flare emissions and in the Van Allen belt.

Shielding, dosimetry techniques, drugs, data correlation and test and evaluation are other areas in which NASA plans further work in under radiation protection.

Roadman also said that the relatively small increase in aerospace medicine was due to the fact that the *Mercury* project is phasing out while *Gemini* and *Apollo* are building up. ⌗

Lovell Hits U.S. Space Fears

LOS ANGELES—American fears that the Soviet Union is driving hard for a military capability in space are completely unfounded, Britain's Sir A. C. Bernard Lovell, director of the Nuffield Radio Astronomy Laboratories, Jodrell Bank, told M/R last week.

"I can find no substance whatsoever for this attitude expressed by your militarists," he said. "On the contrary, all the indications are that the Russian space activities are very closely channeled through their academy. And I think, in fact, one would be quite justified in making the opposite remark—that in the very major part of your scientific space programs carried out through NASA you do obviously have many military programs."

Lovell made the comment during a visit to Space Technology Laboratories, Inc., Los Angeles, with which Jodrell Bank has worked closely in tracking U.S. space probes.

"There is not the slightest evidence that the Russians have these (military) space programs," Lovell declared. His opinions, he said, were based both on the close cooperation Jodrell Bank has had with Russia in tracking of Soviet space vehicles and on visits to his Russian colleagues.

Lovell suggested that the U.S. does not fully appreciate the fact that "the Russians regard the battle with the West not as a battle to be fought with a hot war, but with a cold war to be fought on the scientific and technological front." He said the Russians had forced the issue in this direction with their space activities.

"An extremely important decision was made by your president when he decided to join issue in the so-called race to the moon. By doing this, he has implied that both the Russians and the Americans are going to continue and enhance the expenditure on their space programs, which must already be amounting to something like 5 or 10% of the military budget. This is only the beginning. When it comes to getting men towards the moon and then to the planets, you will be involved in something like 30% of your military budget," the British astronomer said. As a result of this, he added, "the contentious issues are going to pass from this world to outer space."

The Russians see the space race as a way to spread their influence and catch the world markets. "The last thing they want to do is fight a war," Lovell maintained.

• **Red tapes**—In relating how Jodrell Bank had cooperated with Russian colleagues in the Soviet space effort, Lovell said two Russians had worked at Jodrell for more than a week trying to find signals from the Soviet Venus probe. He said he didn't know whether they had contacted the spacecraft because "the Russian scientists took away the tapes of the records which were obtained during their stay with us."

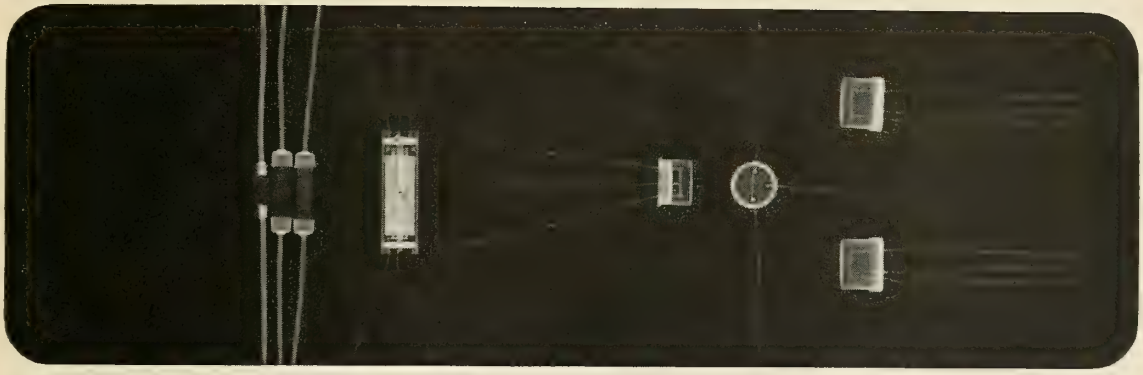
Asked if this seemed like cooperation on the part of the Russians, Lovell said, "Well, we made copies."

The astronomer said Jodrell is spending about one-third of its time trying to settle the issue of whether we live in a "steady-state" or evolutionary universe. The Jodrell studies do not agree with a claim by Cambridge that there there is evidence supporting the evolutionary theory, he added, and no conclusion is possible at this time.

The steady-state theory accounts for expansion of the universe by proposing that matter is continually created in space between the galaxies, forcing them apart. The evolutionary, or "big bang" theory holds the expansion started with explosion of a huge superatom. ⌗

Parts with a single purpose—Success with safety

In a spacecraft an internal flaw in any one component can cause malfunction. So McDonnell Aircraft Corporation uses radiography extensively in the NASA Mercury Project.



Radiograph showing internal conditions of transistors, diodes and resistors for miniaturized instrumentation.

The Mercury Spacecraft designed and constructed by McDonnell Aircraft Corporation, St. Louis, Mo.

In the design and construction of the NASA Mercury Spacecraft, McDonnell Aircraft must supply the greatest safety for the astronaut, the saving of weight and the best use of limited space.These considerations call for instrumentation as perfect as man can make it—and as small.

To be as certain of this perfection as possible, McDonnell employs radiography, both for parts they produce and those provided by suppliers. This includes the inspection of transistors, resistors and diodes to determine the position of internal contacts or reveal any imperfections which might cause malfunction.

Today the use of radiography as an inspection tool extends from castings and welds to all kinds of enclosed assemblies. It is the one method that provides proof of soundness with a lasting record.

If you would like to explore how radiography can help improve your product, your quality control, and thus attract more business, talk to your Kodak x-ray dealer or write us to have a Kodak Technical Sales Representative call.

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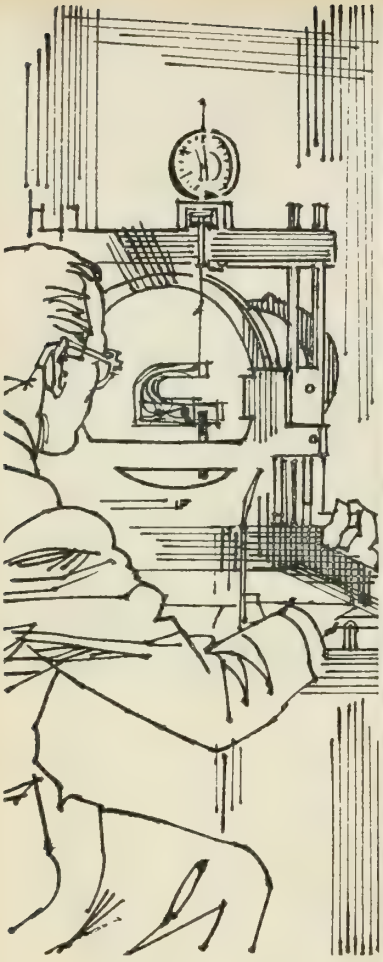

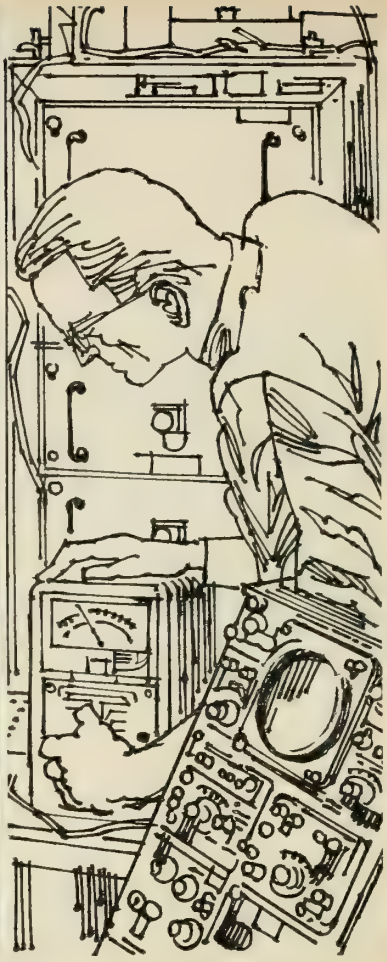

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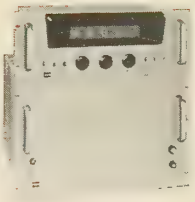

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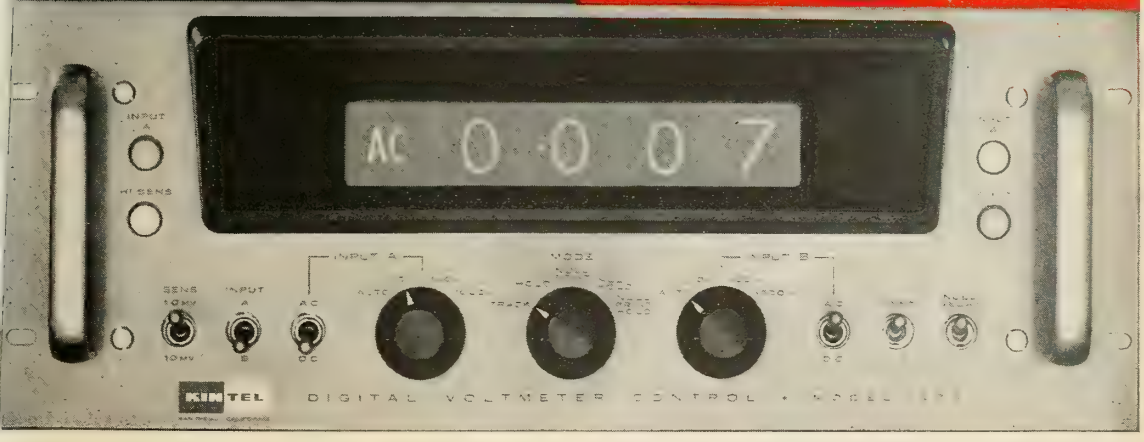

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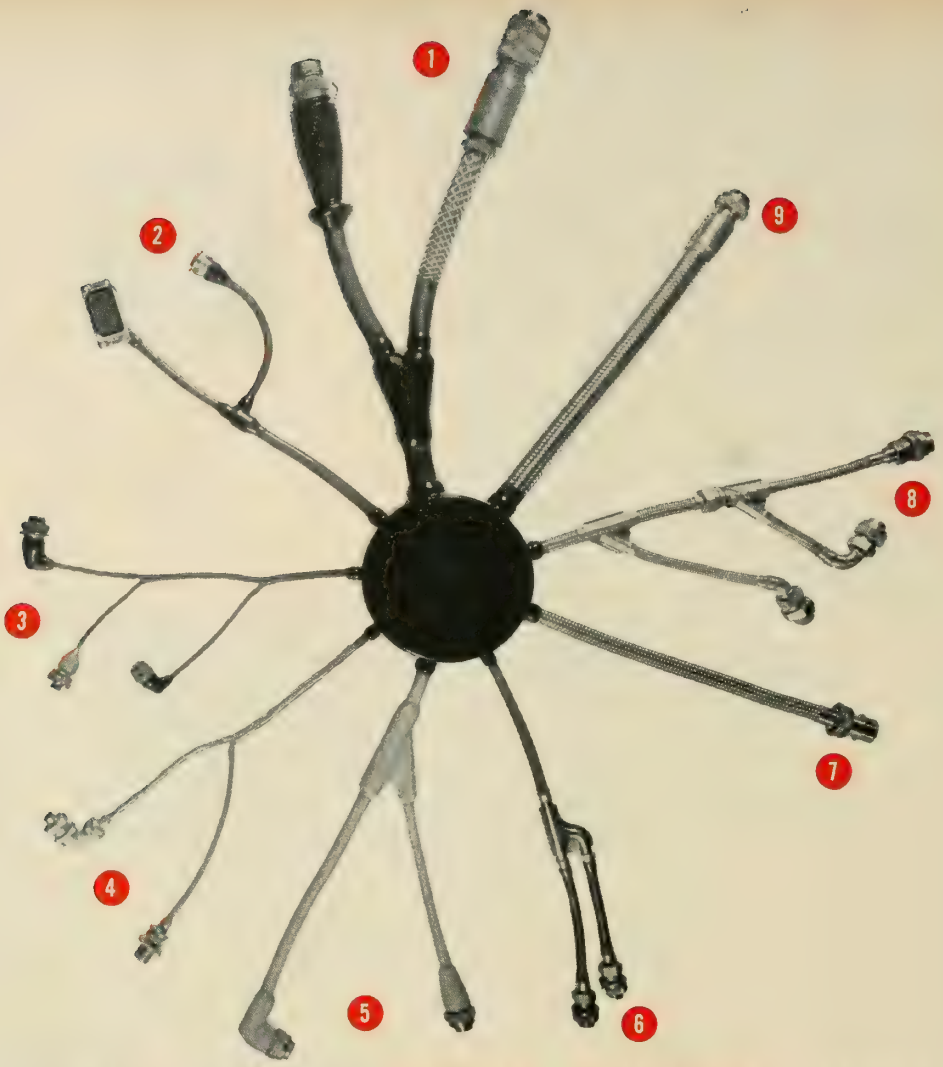

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Technical Countdown

ELECTRONICS

Huge Research Antenna Considered

A pilot model of a mammoth radio telescope, employing a 2000-ft. array antenna and designed to operate over a broad RF range, is being assembled at the Air Force's Cambridge Research Labs in Massachusetts. AFCRL, which manages development of the 1000-ft.-diameter radio telescope now nearing completion at Arecibo, Puerto Rico, reportedly is confident of the feasibility of its newer antenna array design.

New Fuel Cell Progress Reported

A thermally regenerative lithium-hydrogen fuel cell, built by the TAPCO Div. of Thompson Ramo Wooldridge, Inc., has produced up to 3500 amperes/sq. ft. on short circuit. TRW scientists have been working on the system for over three years, in a continuing Air Force-supported search for long-duration unmanned power generation for space use. Operating at a design temperature of 550°C, the fuel cell has demonstrated a flat voltage-current curve for current densities up to 100 amp/sq. ft. At 50% polarization, developers report, a 1400-amp/sq. ft. density is realized. System concept permits zero-g and all-attitude operation.

ADP Growth Cited

Alex, Brown & Sons, in its weekly investments bulletin, predicts marked increases over the next three years in data-processing systems sales. About 7000 general-purpose computers are now in active use, according to the report. By 1965, the firm expects between 15-20 thousand to be in use. These figures are based on a year-end (1961) backlog of 7500 on order. However, the company points out that International Business Machines Corp. is the only major company in the field currently showing a reasonable profit. Sperry Rand is in the black now, the report asserts, but other major producers will not enjoy such a position for at least several years.

BUIC Moving Rapidly

The Electronic Systems Div., Air Force Systems Command, has sent out requests for proposals for the new SAGE back-up system to almost every major U.S. electronics company. The 45 recipients were all expected to attend last week's bidders conference at Hanscom Field, Mass. Called BUIC (Back-up Interceptor Control System), the system will supply emergency support for the 416L system. It will employ semiautomatic data-processing and display facilities at widely dispersed facilities. Proposals are due April 30, and bidders will have the option to propose their own designs for the back-up system.

Telstar Terminal To Be Air-Transported

First of four 20,000-lb. air shipments, comprising the French ground station for satellite communications relay, is scheduled to begin this week. Built by AT&T for the French government, the electronic equipment is compatible with the upcoming *Telstar* satellite system. To be assembled at Issy-Les-Molineaux, the station should be in operation before the second *Telstar* launching this fall. Air France will handle and transport the sensitive electronic equipment to France from New York.

Spare Parts Provisioning To Be Studied

The Army has given IBM the job of studying present parts provisioning methods and recommending a better approach. The goal is an old one: to reduce new parts provisioning and make better use of common items already in the Army supply system. The two-year contract will be a tough one, since the Army is chiefly concerned about the repair parts allowances for future systems—items, in general, with which it has had no previous experience. A board of Army logistics experts will assist the Federal Systems Div. team on the study.

SUPPORT EQUIPMENT

Ultra-High-Vacuum Chambers Tested

Pressures of about 10^{-9} Torr. are being reached regularly in normal operation of two new thermal test chambers, General Electric engineers report. Believed to be the lowest ever reached on a repetitive operating basis, the pressures are equivalent to an orbital altitude of some 400 miles. Now in use at its Valley Forge Space Technology Center, the test chambers were built for GE's Missile & Space Vehicle Dept. by the F. J. Stokes Corp. of Philadelphia. The cylindrical chambers are installed vertically, top-loaded, and provide a working clearance of 5-ft.-dia. by 5-ft.-high.

ADVANCED MATERIALS

Foamed Aluminum for Re-Entry

A sample of foamed aluminum exposed to 2700°F temperatures for 100 hours showed no significant change in tests run by GE-MSVD scientists. In the GE process, foamed metal can vary from 3 to 50% theoretical density. Researchers say the foamed aluminum can be used for re-entry, meteoroid shielding, sandwich core construction and transpiration-cooled surfaces.

Maraging Steel Data Given to Industry

International Nickel Co. has made available to the steel industry all of its data on the properties, commercial applications, melting and processing of the 18, 20 and 25% nickel steels. The maraging steels have notched tensile strengths exceeding 400,000 psi and a resistance to delayed cracking when exposed to severe corrosive atmospheres in a highly stressed condition. The largest single potential application is in marine hull plate. The most promising immediate use is in solid-rocket motor cases.

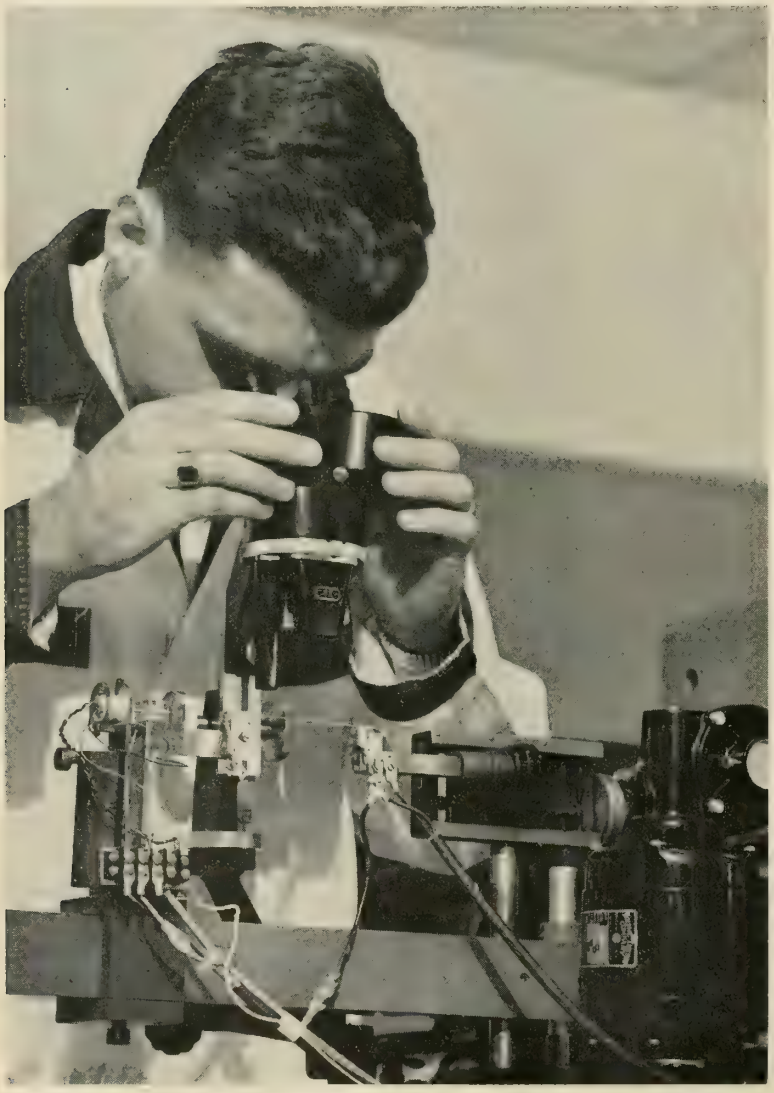
Chemical Vapor Deposition Study Launched

A three-year research program into the technique and theory of chemical vapor deposition, sponsored by some 20 companies is under way at Battelle Memorial Institute. The work may well lead to better high-temperature shields and coatings for space applications. The studies will include crystal nucleation and growth, mechanisms of metal-organic compound decomposition, mechanisms of impurity deposition and vapor-phase transfer processes.

Glass Filament Problems Under Siege

Owens-Corning Fiberglas moves rapidly into wound motor-case problems from materials angle

by John F. Judge



SINGLE-STRAND tensile studies are a fundamental part of the test problem.

THE EXPLOSION in glass technology and production resulting from missile/space applications has confronted one of the major suppliers of glass filaments with a totally new concept in strength—something that never existed as a primary requirement for commercial fibers.

Owens-Corning Fiberglas, whose pioneer work in glass fibers spawned a revolutionary new structural products industry after World War II, is engaged in a massive attack on the complex—and often frustrating—task of translating the extraordinary theoretical strengths of glass fibers into actual production material. The prime impetus: filament-wound pressure chambers for rocket applications.

Filament-wound motor cases are under intensive investigation for applications in the *Polaris* and *Minuteman* programs. Large solid boosters may also involve glass-reinforced pressure chambers.

The one major obstacle facing OCF scientists is a familiar one to many materials suppliers—the lack of meaningful definition of the fabrication problems.

• **Industrial problems**—For years, says one OCF expert, this was a common problem in the whole plastics field. OCF was a leader in reinforced plastics industry for a decade. When reinforced plastics caught on, a host of fabricating problems cropped up. But it was not until the fiber firm began duplicating its customer's processes on a research scale that the problems became clear.

This approach may well be the answer in filament winding—where the extremely high tensile strength of production glass fibers never seem to be completely realized in the end product.

Strength was never the prime factor in commercial glass fiber usage. It definitely is a factor, but other considera-

tions were—and still are—more important. Thermal conductivity, electrical properties, handling characteristics and other characteristics override the strength factor in many of the more familiar consumer and industrial uses of fibers.

But, in the case of the rocket motor chamber, fiber tensile strength is related to the final strength of the end product—an extremely complex and vaguely understood relationship.

For many years it was thought that fiber tensile strength was primarily governed by its diameter. Now it is agreed that the strength is closely related to the fiber forming temperature, and this, in turn, is dependent on other variables such as glass composition and process speeds.

Glass fibers, for all their apparent flexibility, remain glass. OCF experts are positive that one of the keys to unlocking the material's vast potential lies in treating it as such.

In this vein, OCF researchers point to the textile industry. Winding techniques with other fiber types were a long time developing—centuries in the case of wool and cotton. The headache in the missile area is the job of learning to handle glass fiber in a compressed time schedule. It can be done—just as it is possible to develop even higher-strength glasses and associate fiber-resin coupling agents—but it will take a great deal of work.

• **Definition maze**—For anyone not familiar with the complex art of glass-making, one major problem stands out—as it does in all other materials technologies involved in space applications: the meaningful test the route to defining a desired end product characteristic through a simple check on a major constitutent input. OCF experts have not yet found such a test—and strongly doubt the validity of many currently in vogue. There is a great deal of interest in the "single meaningful test." To standardize, the mechanism of reinforcement must be understood.

Single-filament tensile strength is easily determined, but a group of filaments is another matter entirely. Even with the extreme reactivity of glass in the forming stages and the rough handling characteristic of textile operations, a glass fiber pulled from the living room curtain will have almost the same strength it possessed when it was shipped.

Among other things the strength in composite—glass and resin systems—is a function of how well the individual filaments are protected from each other. In addition, the resin transfers stresses from fiber to fiber and tends to bridge flaws in individual strands.

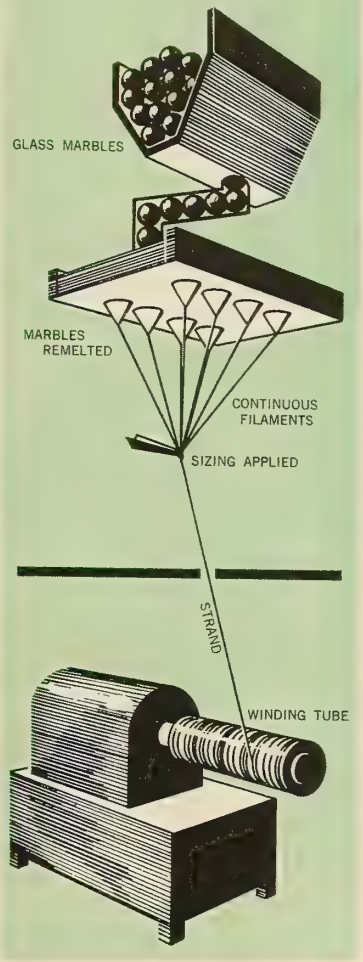
Some tests by winders have shown tremendous resin effects on multi-filament composites. Even with a comparatively poor glass, one resin system provided a composite tensile strength of almost 480,000 psi while another resin consistently tested out lower. These particular tests were not run by OCF, and there is some question as to the exact results, but the overall trend is clear.

OCF scientists know that just about anything capable of impregnating glass fibers will affect the composite tensile strength, other factors discounted for comparison. Some researchers theorize that even if a filament is notched and filled with the proper resin, its tensile strength should almost reach the unnotched figure.

Everyone at the company finds the chief fascination of glass is its potential. There is strong conviction that the material can do almost anything if handled correctly. Between this feeling and reality stands a large number of variables, mechanisms and partially understood phenomena; these involve not only glass, but process controls, resin factors, coupling agent chemistry and last—but hardly least—the fabrication technique.

In the basic glass production, OCF is fairly sure that for each glass composition, there is an optimum forming temperature. Determining this is a bit difficult. Glass does not really "melt" as a metal does—it merely tends to get more fluid. In spite of all the scientific inroads in the area, glass forming and production is still largely an art. While anathema to some in this day and age,

Forming Filaments: The Basic Process



THE PRODUCTION of continuous glass filaments is deceptively simple. Glass "marbles" or carefully weighed and mixed raw-stock batches are continuously fed into a furnace. Molten glass streams from platinum bushings—204 in all—mounted in the furnace bottom.

The filaments are sized, or coated, and caught up on a rapidly revolving winder. This winder revolves much faster than the stream flow rate of glass from the bushings, resulting in an applied tension. This force attenuates the glass while it is in a relatively fluid state, drawing out filaments much smaller than the diameter of the platinum bushings.

This glass filament, 0.00037 in. in diameter, is the basic product of OCF. It can be chopped, blown, or woven into a vast number of familiar products through a series of processes. But the almost invisible output of the platinum bushing remains the heart of the glass composite market.

Virgin glass fibers drawn from the standard "E" glass composition have tensile strengths on the order of 500,000 psi. New glass compositions have even higher strength—one promising formulation runs 30% or more above the standard "E" glass.

The current studies are involved in discovering and capitalizing on the relationship between strength, modulus and weight—and glass composition, forming temperatures and process controls. In some cases, the actual strength falls below 50% theoretical—leaving ample room for improvement.

The structure of the filament itself is under extensive investigation at OCF, other firms, and universities. Each filament represents a structure which might be described as being a condition of homogeneous heterogeniety—the basic structure is probably repeated but with enough distortion to preclude crystal formation—symmetry must be avoided.

Another area of theory deals with the effect of additives on the basic structure. Still another fertile field is the nature of the coupling agent bond. Glass filaments must be protected against themselves, and yet must be amenable to resins.

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Owens Corning Fiberglas-Corning Glass-Libbey Owens Ford-Owens Illinois ???

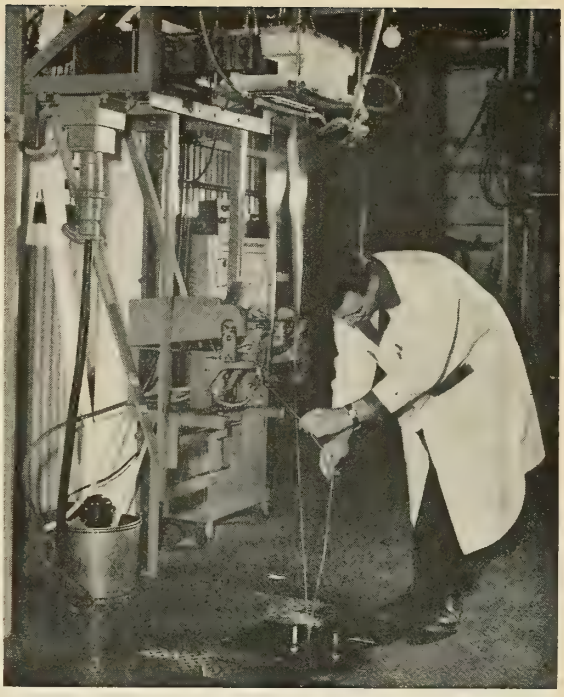
It all started in 1888, when Edward D. Libbey founded Libbey Glass Co. in Toledo, Ohio. Libbey's superintendent, Michael J. Owens, invented the glass bottle-making machine and went into business, with Libbey's backing, under the name Owens Bottle Machine Co.

The versatile Owens came up with another development, this time in plate glass, and—again with Libbey's cooperation—the Libbey-Owens Sheet Glass Co. was created.

In 1930, Libbey-Owens merged with the Edward Ford Plate Glass Co. to form the Libbey-Owens-Ford Glass Co. Owens Bottle bought up the Illinois Glass Co. and Owens-Illinois Glass Co. was born.

A series of events in research programs led Owens-Illinois and Corning Glass Works, Corning, N.Y., to form the Owens-Corning Fiberglas Corp in 1938—to produce products from the newly perfected glass fiber techniques. OCF operates independently, but both parent firms retain some financial interests.

In 1944, Randolph H. Barnard formed Glass Fibers Inc., which merged with the L-O-F Fiber-Glass Division created in 1951 and known as L-O-F Glass Fibers Co. Johns-Manville Corp. bought this L-O-F division in 1958, forming a new production and research subsidiary, Johns-Manville Fiber Glass Co. The only connection among these companies now is in the confusing name situation.



NEWLY FORMED FILAMENTS are easily visible when off the winder. In actual production, mechanical attenuation draws the filaments almost too thin to be seen.

this stubborn resistance of the so called "rigid liquid" to present methods and apparatus has a positive side. It speaks well for its future.

As one OCF researcher puts it, "We haven't begun to understand all we know . . . and when we do, we'll still be saying the same thing, only farther down the line."

The filament winding work aimed at space problems is concentrated in the new OCF Technical Center at Granville, Ohio. The Center operates as a unit, although it is divided into several distinct laboratories. By far the major effort is in commercially oriented research and development. But in basic glass technology, the line is hard to find and the input to filament winding is substantial.

The firm funds research activities at a current annual rate in excess of $6 million and, while the eye is always on the product, a vast amount of basic work is continuously under way.

The flexibility of the center is best illustrated by the fact that it is currently shipping a newly developed high-strength filament to winders for evaluation purposes while still devoting a major effort to basic property-composition studies. The high-strength glass filament is the result of Air Force-funded studies at OCF; work is still in progress to improve the process.

A separate section of OCF's Huntington, Pa., plant is being readied for production processing of these new filaments. Some production is already in being. The positions in operation can easily handle filament requirements for any current program. There is ample room for more units.

The test problem runs throughout the Center. Almost every laboratory involved in glass-reinforced plastics technology has a hand in this. It is apparent that OCF experts consider that the whole field of filament winding is in its infancy. No one in the industry disagrees.

• **Wool, cotton or glass—**The labs have always used textile methods to define glass filaments—simply because the major end-use, in this respect, was in textiles. But, with the advent of filament winding, glass was treated as glass, and the results were startling. Together with this is the fact that many winders still think in terms of textile technology; the terms are similar, but the material is basically different.

Textile manufacturers go to considerable pains to achieve equal tension on all strands. This type of precision effort is not always carried into filament-winding of motor cases.

The Center covers all of the classic disciplines—physics, chemistry, metallurgy, glass research and technology and test programs. Since OCF is basically a process company, the lab has a major section devoted to mechanical and instrumentation research. The Center is well equipped with standard instruments and apparatus—including three Instrons in a row. There is also a great deal of individually-developed apparatus designed by glassmen for glass. Single and multi-bushing glass furnaces and winding apparatus are present in more-than-adequate numbers. Filament-winding equipment will soon be producing test bottles.

But the real driving force is the staff and the centuries of collective experience in glass they represent. This is augmented by a high degree of theoretical and practical ability in surface chemistry, resins and coupling agent technology.

Given a defined problem, the Center has no lack of confidence in its ability to come through eventually with the solution. But the current major task lies in defining the problems of filament winding.

Tucked in with the Technical Center, and serving as another womb for new glass application ideas in any area, is the Pioneering Laboratories. This group forms a second research technique into problem areas, but its approach is unique. Led by Dr. Games Slayter, vice president research, the group explores ideas and concepts best described as one step behind basic research.

But there is a responsibility to follow these ideas right into production, if they so develop. There is a concept totality. After the technical and theoretical basis has been established, the next move is into the process, then into the plant and—finally—to sell it.

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glass is in the vast availability of the raw materials. This has provided the group with a two-way point of departure: one on into glass itself, and the other back into "earth sciences".

• **Synergistic concept**—The Pioneering Labs are deeply involved in developing and understanding the theory of two-phase materials. A concise explanation of this theory was written for the January, 1962, issue of *Scientific American* by Dr. Slayter.

In brief, the high specific strengths of "Fiberglas" plastics come from a basic fundamental principle of materials science defined by Dr. Slayter as a "two-phase" principle of materials structure and strength.

One example mentioned was that of wood: a combination of a relatively high-strength, high-modulus fiber—cellulose—with a low-modulus plastic matrix—lignin. The advantages of such a structure, says Dr. Slayter, are demonstrated in the bamboo pole.

The long, high-strength fibers, arrayed longitudinally in parallel, have a modulus of elasticity in the 4,000,000 psi area; the containing matrix has a modulus of about 1,000,000 psi. Any break in the fibers is isolated by the supporting matrix, and the yielding elasticity of the matrix transfers the loading stress to other intact fibers.

This and other evidence in nature of the composite approach to strength is imitated by man in many areas. Dr. Slayter says that a general theoretical and quantitative expression of the concept remains to be developed.

The Pioneering Lab has developed a series or family of glass "pellets" which have a very low coefficient of expansion and low thermal conductivity and are extremely light. The pellets could function as a core in filament-wound sandwich structures providing good insulation characteristics as well as strength. There is some talk of possibly applying this type of structure for liquid-rocket fuel tankage.

OCF researchers did not disclose the manufacturing techniques involved in the production of these pellets except to say it is like "popping corn."

Another concept receiving attention at the Pioneering Lab is the feasibility of using a "B" staged resin to carry a ceramic fiber. In structural usage, this could result in a motor case composed of oriented zirconia single-crystal fibers. The carrier has a function similar to a preform, and the curing segment would proceed normally. The strength and temperature capabilities of such a case would be formidable—as is the task of reaching this stage of development.

Such work as this is helping to establish directions in achieving the rather distant goal of single-crystal continuous filaments. ⁂

Mariner To Test Mars Life Theories

Expert opinion leans increasingly toward the existence of plant life; spacecraft will probe in '64

by William Beller

THE VENUS AND MARS fly-by program—*Mariner B*—on which the National Aeronautics and Space Administration wants to spend $74 million in Fiscal 1963, may have a spectacular payoff if it verifies recent speculations by an internationally known biologist.

This scientist believes Mars may have a flourishing plant life, some of its forms resembling our own higher plants. If this is true, he declares, we should expect to discover Martian mobile forms comparable to our plant-eating animals.

"From there it is but one more step —granted, a big one—to intelligent being," says the biologist—Dr. Frank B. Salisbury, Professor of Plant Physiology at Colorado State University.

The existence of life on Mars seems to be the only explanation for certain Martian phenomena, Dr. Salisbury maintains. Writing in a recent issue of *Science*, publication of the American Association for the Advancement of Science, he suggests that we be prepared for some interesting surprises in biochemistry—water perhaps acting as vitamins, and the decay products of Martian life being iron oxides.

• **Mars in '64**—The *Mariner B*, designed to fly on *Centaur* in 1964, will not only be capable of fly-by missions to Mars and Venus—it also will be able to carry a small planetary atmospheric entry capsule.

The first goal of the *Mariner* project was to send *Mariner A* fly-bys to Venus during 1962. However, problems with *Centaur* persuaded NASA officials to terminate *Mariner A* and replace it with a lighter version of the *Mariner* spacecraft—Model R—to be launched by an *Atlas-Agena*. Waiting for *Centaur* would have meant at least a year's delay in the program, since the next favorable time for a Venus launch is 1964.

As a result of the two flights of *Mariner R* planned for this year, NASA hopes to have enough data to design and test-fly a vehicle on an interplanetary mission in 1963. The trajectory will be chosen to check out the spacecraft subsystems expected to go on the *Mariner B* fly-bys in 1964.

NASA concurs with Salisbury that the basic question about Mars is whether life exists there. Early experiments are therefore being designed to solve the appropriate detection problems: an infrared spectograph will be carried to determine the existence and location of organic molecules. The upper atmosphere will be examined for ozone, to see whether Mars' surface is protected from ultraviolet radiations which in large doses are damaging to terrestrial life.

Since the Martian atmosphere is clear, the spacecraft will carry an optical system mated to a vidicon capable of taking and transmitting photographs of the terrain.

The hitch-hiking capsule on board the spacecraft will carry pressure-accelerometer instruments to probe the nature of the planetary atmosphere, and other instruments to detect the existence of life.

Mariner A funding terminates in Fiscal 1962 because of its replacement by *Mariner R*. Much of the hardware developed for the *Mariner A* is being used on *Mariner R;* similarly, much of the development effort on the various *Mariner A* subsystems will be used in *Mariner B*.

Mariner R funding peaks sharply in Fiscal 1962—reflecting the fact that almost all work must be completed by the end of the fiscal year in order to meet the launch opportunity date.

The *Mariner B* request for Fiscal 1963 reflects the heavy hardware requirements, since it is in this year that equipment must be purchased for both the test flight late in calendar 1963 and the planetary missions early in calendar 1964. Fiscal 1962 funds met the *Mariner B* pre-hardware requirement; the Fiscal 1963 request is to cover prototype and flight hardware, the necessary ground equipment for check-out and test, and the testing phase itself.

• **Unearthly life**—As near as astronomers can make out, the Martian atmosphere shows the following features:

—At the planet's surface, an atmospheric pressure between 6 and 10 centimeters of mercury—about 0.1 the earth's atmospheric pressure.

—A carbon dioxide content twice to 13 times that of the earth's atmosphere, with the higher value being the more likely.

—No oxygen, ozone or water vapor present—although on occasion there may be ice crystals.

—The bulk of the planet's atmosphere made up of nitrogen plus some argon.

—Temperature varying between −101°C and +30°C, depending on season and latitude.

These characteristics would undoubtedly discourage life as we know it. However, there is no reason to assume that life on Mars would resemble Earth's.

Most of the evidence strongly suggesting life on the planet is based on the changing colors of the Martian surface, somewhat in rhythm with the changing seasons. The colors are described as also varying from year to year.

The dominant color of the dark areas on Mars is gray, although some observers believe they see a greenish hue mixed in. With spring, the color darkens, much like regions of the Earth when forests take on new foliage. At the rim of the receding ice cap the colors appear to change to delicate pastels. When winter comes, the areas become less sharply defined, lighter, and begin returning to the dominant gray.

Another strong argument in favor of life on Mars was recently given by the American astronomer William Sinton. Using the 200-in. Mount Palomar telescope, Sinton reported, he secured infrared spectra of Mars showing absorption bands characteristic of the organic molecules found in terrestrial living organisms.

Sinton's discovery was hailed by Dr. Gerard de Vaucoulers, Associate Professor of Astronomy at the University of Texas, as being "the most direct evidence of life on another planet yet offered. . . ." As an afterthought, de

NASA Requested Funding for Mariner

(in millions of dollars)

MARINER A	FY 1961	FY 1962	FY 1963
Project Management and Support	0.498	0.431	
Systems Analysis & Integration	0.740	0.409	
Structure Design & Development	0.891	0.195	
Documentation & Reports	0.369	0.090	
Data Reduction & Processing	0.803	0.735	
Scientific Experiments	2.569	1.871	
Environmental Requirements & Testing	0.432	0.465	
Communication & Telemetry	1.562	1.928	
Guidance & Control	3.638	0.951	
Power Systems & Energy Control	0.765	0.250	
Pyrotechnics Design & Development	0.185		
Instrumentation Services & Facilities	0.143	0.197	
Computer Support	0.473	0.098	
Total, Mariner A	**13.068**	**7.620**	

MARINER R			
Project Management and Support		1.370	0.270
Systems Analysis & Integration		1.038	0.457
Structural Design & Development		0.851	0.145
AMR Facilities & Administration		0.099	0.090
Documentation & Reports		0.239	0.080
Data Reduction & Processing		0.365	0.280
Operations		0.238	0.340
Scientific Experiments		1.310	0.285
Environmental Requirements & Testing		1.232	
Communications & Telemetry		2.949	0.450
Guidance & Control		2.065	0.350
Instrumentation Service & Facilities		0.201	0.050
Power Systems & Energy Control		0.697	0.028
Computer Support		0.832	0.175
		13.486	3.000
Atlas-Agena Launch Vehicles		10.292	6.240
Total, Mariner R		**23.778**	**9.240**

MARINER B			
Project Management and Support		0.765	3.100
Systems Analysis & Integration	0.157	1.022	4.900
Structural Design & Development	0.278	1.635	4.050
AMR Facilities & Administration			0.260
Documentation & Reports	0.047	0.190	0.360
Data Reduction & Processing		0.296	3.600
Operations			0.520
Scientific Experiments	0.410	2.320	8.845
Environmental Requirements & Testing		0.142	3.495
Communications & Telemetry	0.183	1.268	7.030
Guidance & Control	0.594	3.202	10.757
TV Systems		0.364	1.700
Power Systems & Energy Control	0.048	0.509	6.543
Instrumentation Services & Facilities		0.101	0.875
Computer Support		0.070	0.585
	1.717	11.884	56.620
Centaur Launch Vehicle		1.074	17.100
Total, Mariner B	**1.717**	**12.958**	**73.720**

Vaucouleurs said, ". . . although a narrow margin of doubt remains until proof is obtained by direct exploration of the Martian surface."

• **A new way of life**—Salisbury suggests that it is easier to envision higher plants as being capable of living on Mars than it is to accept the often-discussed lichens as possibilities.

He points out that ultraviolet light probably is the least serious of the adverse environmental conditions to be met on the planet; he observes that "we would only have to add some sort of shielding pigments to our Martian organism to avoid this difficulty—pigments such as are found in certain fungi in Death Valley. . . ."

Modification of the plants so they can survive under the temperature extremes on Mars is also considered by Salisbury to be a relatively simple matter: the Martian organisms could present a broad, flat surface to sunlight during the day—a thin organ such as a leaf would appear ideally suited for the job. "If this leaf could roll up into a small cylinder at night—a phenomenon not without precedent on Earth—this would cut down night-time heat loss by radiation," he explains.

To conserve heat under the sub-zero temperatures organisms would experience during the Martian nights, "it is simplest to imagine that the plants freeze every night and thaw out the next day—and are not hurt by this."

"I have wondered if water on Mars might not act more like a vitamin than like a primary solvent," says Salisbury. "A certain amount of hydrogen and oxygen would be supplied for essential reactions, but Martian biochemistry might not depend on these elements as extensively as our own does."

On Mars, oxygen appears to be tied up in iron compounds on the deserts. Salisbury asks how life can proceed if oxygen produced by photosynthesis is immediately tied up and made unavailable for future use in respiration. He suggests that this is the most difficult of the dilemmas in our speculations.

He sees one possible solution: the oxygen might be replaced by nitrogen, with its many oxidation states. He also recognizes the alternate suggestion that "the Martian organisms may split off oxygen from iron oxides in the desert soils in a manner analogous to the way in which oxygen is split from water through photosynthesis in terrestrial plants."

The consequence, according to Salisbury, would be that oxygen would be used in the organism's metabolism, and the decay process might involve a direct return to the original combinations with iron—a final descent to rust. ⌗

Northrop put the little dipper in the ocean.

To get the precise position fix they need for missile launching after spending weeks or months under water, Polaris submarines will rely on two Northrop-developed celestial navigation devices, the Type 11 Periscope and the Radiometric Sextant.

In clear weather, the Type 11 Periscope can be extended above the surface to take an accurate optical fix on preselected stars. If the stars are obscured, the all-weather Radiometric Sextant would be used to track radio "noise" from the sun or the moon.

Both of these systems are remarkably accurate, even while being buffeted by waves and subjected to other severe stresses. They were developed for the Navy by the Marine Equipment Department of Northrop's Nortronics Division.

NORTHROP

Wind Tunnel To Use Plasma Arc Heat

by Michael Getler

A NEW hypersonic wind tunnel will be used at Wright-Patterson AFB, Dayton, Ohio, to study the aerodynamic behavior of spacecraft and missile shapes during the severe phase of re-entry.

The two-ft.-diameter tunnel, now under construction, will operate in the 2-4-mw power input range with nozzle exit diameters from 7-in. to 2-ft.

Supplying the heat for the tunnel will be a new high-voltage plasma arc air heater, reported to be capable of producing simulated atmospheric chemistry, density, and velocity conditions covering a broad range of possible re-entry paths.

This use of plasma arc heater devices should represent a major advance in simulation of extreme environmental parameters over regenerative storage type (or pebblebed) heating elements. The temperature and enthalpy (heat content per unit mass) levels attainable through plasma arc heating are expected to be several times those achieved with the pebblebed units (these storage heaters are roughly limited in range to 4500°R. and 2000 BTU/lb).

Developer of the heating element going into the AF tunnel is the Linde Co., a division of Union Carbide Corp. Officials of the firm claim the 4-mw (input) heater will operate continuously for periods up to 15 minutes at output efficiencies between 50 and 60% and with negligible contamination within the air stream. Whatever contamination is present (reportedly less than 0.1% by weight) is due to copper electrode erosion.

• **Early tests favorable**—Engineers in the arc development program at Dayton have been conducting tests with a lower-powered (1-mw input) device shipped last May by Linde. They report that they are "quite pleased" with the performance. The smaller heater is Linde's model N-1000; the unit to be operated in June is designated N-4000.

Builder of the power supply for the heater is A. O. Smith Corp. of Milwaukee.

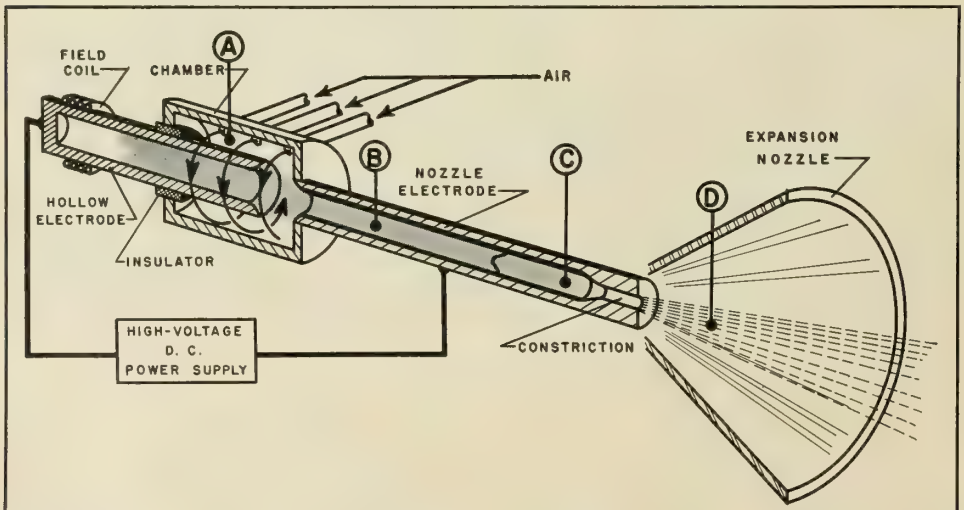
Much of Linde's effort to develop a heater for adaptation to hypersonic wind tunnel testing has been supported by the Air Force's Aeronautical Systems Division at Wright-Patterson. Since February, 1959, the firm has been awarded three study and experimental contracts totaling just over $400,000.

A fourth follow-on contract—aimed at further increasing the enthalpy and pressure ranges in order to test at even more severe re-entry angles—is understood to be in negotiation.

Depending on the operating conditions selected, Linde engineers claim the useful stagnation temperature range for the device will be from 5500°R to 9500°R, corresponding to an enthalpy range of 1800 to 4500 BTU/lb. Air flow rates from below 0.01 to above 1.0 lb./sec can be accommodated. Maximum temperature and enthalpy of 12,000°R and 9000 BTU/lb. have been achieved but at necessarily low pressures, flow rates, and power inputs.

• **DC operation**—The heating system, designed for 1500 psia operation, uses direct current at relatively high voltages (up to 10,000 volts) and low currents (to 1500 amps) to promote high efficiency and low electrode erosion.

Linde's development of a plasma arc air heater for flight simulation purposes is basically an outgrowth of the firm's plasma arc welding efforts. The company recently announced that a line of these new heating elements would be made commercially available on an off-the-shelf basis for use either in aerodynamic studies or materials testing. The four units to be offered correspond to power input rating of 60, 250, 1000, and 4000 kw. ⌗



IN PLASMA ARC HEATER air injected tangentially into chamber (A) is ionized and heated to 5500-1200°R in constricted, high-voltage electric arc (B). Plasma jet issuing from arc at high pressure (C) flows through nozzle constriction to low-pressure area (D) where expansion converts its potential energy into kinetic energy. Resulting high-velocity plasma jet is injected into test section of wind tunnel to simulate conditions encountered during re-entry into Earth's atmosphere at speeds approaching Mach 20.

Today, the design and development of space systems, vehicles and weapon systems is achieving an even greater degree of importance than before. Expenditures are increasing. The pace is being stepped up.

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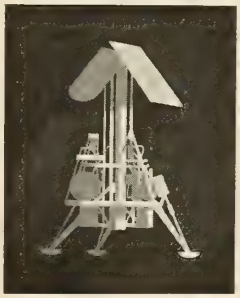

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Tax Court's Boeing Decision Praised

by Selig Altschul*

THE RECENT decision of the United States Tax Court finding that the Boeing Airplane Company made excess profits of $13 million on government contracts in 1952 greatly strengthens the renegotiation process at a time when its value is being questioned (see box).

The Renegotiation Act, as amended, now applies to any contractor which does $1 million of defense business with the Government.

The elements comprising the basis of the Renegotiation Board's findings in reviewing alleged excessive profits are many. As provided by the Renegotiation Act of 1951, as amended, the Board must take into consideration the following factors: (1) the reasonableness of costs and profits, measured against volume of production, normal earnings and comparison of war and peacetime products; (2) net worth as related to amount and source of public and private capital employed; (3) risk assumed, including that incident to reasonable pricing policies; (4) contribution to defense, including incentive and developmental contribution and cooperation with the Government in supplying technical assistance; (5) character of business, source and nature of materials, complexity of subcontracting and rate of turnover; (6) consideration of the public interest in fair and equitable dealings with contractors.

• **Special case**—The recent decision as it pertains to Boeing, while perhaps disconcerting to other petitioners now before the Tax Court, does not necessarily doom their cases.

There were special circumstances present in the Boeing case which were succinctly set forth in the decision by Tax Court Judge Graydon G. Withey which may not apply to other renegotiation cases now pending before other members of the sixteen-man Tax Court.

A key finding in the Boeing 1952 case as enunciated by Judge Withey declared that: "Because of the assurance of return of all costs expended or incurred by (Boeing) with respect to its performance of the contracts here involved and the periodic payment of profits which are based upon negotiated estimated costs, we find (Boeing) incurred no risk or loss thereunder within the meaning of the Act. . . ."

The Court further asserted, ". . . Because (Boeing's) real profit was not determinable until the incentive contracts had been fully performed, it follows that under those contracts such profits were finally fixed when actual costs were known. . . . We see no justification for the payment to (Boeing) of more profit than that which would accrue to it by application of a reasonable percentage profit rate to actual as distinguished from estimated costs."

In this particular case, because of the lack of most of the statutory criteria for determining the comparative reasonableness or excessiveness of Boeing's 1952 profits, the Court used the net worth factor to a large degree in determining the reasonableness or excessiveness of the company's profits on a comparison to other business. While Boeing earned 98% on its net worth based on its beginning 1952 book values, the court adjusted this valuation to include what was "concluded as fair value for . . . design, engineering and manufacturing know-how and used an average 1952 book net worth . . ." Under this method, the court arrived at a ratio of profit to net worth of about 50%.

The court brushed aside the plea to use as a guide the comparative ratio of profit to sales. And here again may be found a condition peculiar to Boeing to a far greater extent relative to other Government contractors. The court declared that one of the important differences which may exist for 1952 between Boeing and other manufacturers was the "great preponderance in (Boeing's) case of Government-furnished facilities and production equipment over that furnished by (Boeing)."

The Tax Court went further than the Renegotiation Board's original determination that excess profits of $10 million were realized in 1952.

• **Pending cases**—Other major renegotiation case proceedings pending:

Grumman: Was ordered to refund, after taxes, $710,000 of 1951 earnings, $1,340,00 for 1953, $1,170,000 for 1954 and $165,000 for 1955. While the company petitioned the Tax Court for a redetermination of 1951 and 1953 alleged excessive profits, the suit was subsequently withdrawn. Currently, Grumman's renegotiation proceedings have been concluded through 1958.

Douglas: Has a total of $19.5 million in excessive profits (before tax credits) alleged for three years as follows: 1953, $6 million; 1954, $6 million and $7.5 million for 1955. All cases pending before the Tax Court.

Lockheed: Has a total of $19.5 million in excessive profits (before tax credits) alleged for four years as follows: 1953, $6 million; 1954, $6 million; 1955, $3.5 million and 1956, $4 million. All cases pending in the Tax Court.

Martin: Has a total of $19.3 million in excessive profits (before tax credits) alleged for four years as follows: 1953, $3.5 million; 1954, $6.5 million; 1955, $3.5 million; and 1956, $4.8 million. All cases pending in the Tax Court.

North American: Has a total of $29 million in excessive profits (before tax credits) alleged for 1953 through 1955 inclusive plus an undisclosed gross amount for 1958. For 1953, $6 million; 1954, $14 million (these two years combined into one petition and heard by the Tax Court Renegotiation Board upped totals to $16 million and $21,500,000 after witnesses were heard in the case), 1955, $9 million. A determination was made that no excessive profits were realized during 1956 and 1957. Determinations have yet to be made for 1959 through 1961 inclusive. The company has filed petitions with the United States Tax Court protesting the impositions of the Renegotiation Board for the years noted. ⌗

DOD Seeks Clarification

The Pentagon has asked the U.S. Tax Court to issue a "supplementary clarifying opinion" on its findings in the Boeing renegotiation case.

The unusual request, included in the Justice Department's brief asking the court to deny Boeing's appeal for a revision of the opinion, is designed to spell out the effect the decision will have on incentive contracting.

Defense Secretary McNamara recently told Congress that the Boeing ruling could "undermine" DOD's program to reward or penalize contractors for superior or inferior performance.

The Justice Department said that if Boeing is unable to understand the court's reasoning, it can be argued that other defense contractors may be similarly uncertain."

Mr. Altschul is a recognized aerospace financial authority serving industry, government, and the financial community in advisory capacities.

soviet affairs

by Dr. Albert Parry

Without cybernetics, Soviet space successes

would have never been possible. Yet only eight years ago certain Soviet dogmatists denounced the entire science of cybernetics. Thus, with wonder and indignation, writes the world-renowned atomic physicist Professor Peter Kapitsa in his article "Theory, Experiment, Practice" in the Moscow weekly *Ekonomicheskaya Gazeta* for March 26. Derisively he quotes the Soviet *Philosophical Dictionary,* published in 1954 soon after Stalin's death, and still reflecting the official Stalinist stand: "Cybernetics is a reactionary pseudo-science, emerging in the United States after World War II and widely spreading in other capitalistic countries as well."

Seizing upon the title of the dictionary,

Professor Kapitsa mocks the Stalinists as "philosophers" who "made a mistake," but who as philosophers should have foreseen further development of natural sciences instead of pronouncing their rigid judgments of a past phase of these sciences. Never once does he call them Stalinists; the professor merely says that "this mistake has been corrected," then goes on: "Had our scientists at the time, in 1954, obeyed the philosophers; had they adopted this definition [of cybernetics] as their directive for the further development of this science, we can say that our conquest of outer space, of which all of us are justly proud and for which the whole world respects us, could not have happened, since it is impossible to guide a spaceship without cybernetic machines."

The Soviet atomic bomb also

would have been an impossibility, Professor Kapitsa continues, had the Soviet "philosophers" been heeded in their denunciation of another scientific milestone: Albert Einstein's work on relativity. Early in Einstein's time, physicists confirmed his theory by their experiments with atomic particles. "To understand these experiments a profound knowledge of the latest physics was needed, but certain philosophers lacked such knowledge," Kapitsa writes. "And now physicists confirm the Einstein law, not on separate atoms, but on the scale of the atom bomb. How embarrassed our physicists would have been had they followed the certain philosophers' conclusions and had they ceased their work on the problem of applying the theory of relativity in nuclear physics!"

Kapitsa hits at Trofim Lysenko

for his interference in genetics. Without naming him, he clearly blames Lysenko for "the incorrect generalizations made by our philosophers, not alone in the field of physics, but also in biology." He follows this up with a daring criticism of dialectics, that pet of the Marxists, writing: "Application of dialectics in the realm of natural sciences demands an exceptionally thorough knowledge of experimental facts and their theoretical generalization. Without this, dialectics by itself cannot solve the question."

Too little experimentation goes on

in the Soviet Union these days, Professor Kapitsa warns in his significant article. He sees in this a danger signal for the future of Soviet science. As editor of the journal *Eksperimentalnaya i Teoreticheskaya Fizika,* he says he knows this lag from the disparity in articles submitted to him from all over Russia: the theme of these articles is theoretical physics, as opposed to experimental physics, by ratios of 3 to 1 and even 4 to 1. "Young people, on graduating from higher schools, prefer theoretical work to experimental," he points out. "We cannot permit any lag in experimental physics, for this would greatly hinder the normal growth of our physics—would prevent it from occupying leading positions in the world's science along the entire front of most important researches."

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contracts

AIR FORCE

$38,373,318—**The Boeing Co.**, Seattle, for production of *Minuteman* missiles, training equipment, spare parts and production and supplying of ground support equipment (2 contracts).

$36,536,000—**Thiokol Chemical Corp.**, Bristol, Pa., for continued research and development for the Stage I *Minuteman* motor.

$29,930,750—**Martin-Marietta Corp.**, Baltimore, for R&D for the *Titan II* weapon system, work to be done in Denver, Baltimore and Cape Canaveral; for production of spare parts, special tools and test equipment for operational support of *Titan I* bases, work to be done in Denver; and for R&D of a space program launch vehicle (3 contracts).

$16,000,000—**North American Aviation, Inc.**, Downey, Calif., for R&D for *Minuteman* guidance and control.

$11,067,008—**The Boeing Co.**, Seattle, for assembly and checkout of *Minuteman* missile site equipment at Malmstrom AFB, Great Falls, Mont., Whiteman AFB, Knob Knoster, Mo., and Minot AFB, Minot, N. D. (3 contracts).

$10,000,000—**Westinghouse Electric Corp.**, Baltimore, for AN/FPS-27 search radar sets.

$8,300,000—**General Motors Corp.**, Milwaukee, for inertial guidance systems for the *Titan II* missile.

$7,000,000—**The Boeing Co.**, Seattle, for work on the *Dyna-Soar* program.

$6,300,000—**Melpar, Inc.**, Falls Church, Va., for circuit board assemblies and modules for the *Minuteman* inertial guidance system.

$5,228,818—**American Bosch Arma Corp.**, Garden City, N.Y., for depot tooling to support the *Atlas* organic maintenance program, for spares for *Atlas* airborne guidance systems, and for depot level maintenance in support of the *Atlas* all-inertial guidance system (3 contracts).

$4,750,000—**Douglas Aircraft Co.**, Santa Monica, Calif., for the *MB-1 Genie* missile; also undisclosed amount for 12 *Thor* boosters for future space program requirements.

$2,849,000 — **Space Technology Laboratories, Inc.**, Los Angeles, for systems engineering and technical direction for *Atlas*, *Titan* and *Minuteman* weapon systems.

$2,000,000—**Federal Electric Corp.**, Paramus, N.J., for installation of an interim tropospheric scatter communication system.

$1,850,000—**Douglas Aircraft Co., Inc.**, Santa Monica, Calif., for *Thor* space boosters.

$1,512,000—**General Electric Co.**, Syracuse, N.Y., for airborne guidance equipment for space programs.

$1,500,000—**General Telephone & Electronics Corp.**, Waltham, Mass., for expansion of missile site communications systems at Francis E. Warren and Schilling AFB's.

$1,472,821—**General Dynamics Corp.**, San Diego, for supplemental contract for launch services and related work at Point Arguello.

$1,200,000—**Aerojet-General Corp.**, Sacramento, for an engineering analysis development program in support of liquid-rocket engines and related equipment for *Titan* missiles.

$1,200,000—**Kellogg Switchboard and Supply Co.**, Chicago, for design and engineering in support of *Atlas* ground communication systems and equipment.

$1,196,486—**General Dynamics Corp.**, San Diego, for ground support equipment and airborne spares for *Atlas* missiles.

$1,000,000—**Ford Motor Co.**, Dearborn, Mich., for work on operational subsystems and service for *Atlas* and *Titan* missiles.

$370,000—**Fairchild Semiconductors Corp.**, Mountain View, Calif., for transistors for the *Minuteman* ICBM.

$100,000—**Meridian Metalcraft, Inc.**, Whittier, Calif., for power dividers for the *Minuteman* ICBM systems.

$100,000—**Emertron, Inc., Emerson Research Laboratory division**, Silver Spring, Md., for a research and study program aimed at resolution of jamming difficulties in aerospace communications.

ARMY

$4,540,000—**Blount Brothers Construction Co.**, Montgomery, Ala., for construction of a second launch pad and umbilical mast for Complex 37 for *Saturn* vehicles at Cape Canaveral.

$4,200,000—**Martin-Marietta Corp.**, Baltimore, for additional work on the *Pershing* missile system.

$3,156,171—**Paul Smith Construction Co.**, Orlando, Fla., for dismantling an *Atlas* gantry and umbilical mast and replacing them with a taller and more elaborate launch facility for the *Atlas-Agena* vehicle at Cape Canaveral.

$1,537,494—**Radio Corp. of America**, Moorestown, N.J., for design and fabrication of radar materiel, to be used in collecting data on re-entry of rocket vehicles.

$1,177,828—**Iowa Ordnance Plant**, Burlington, Iowa, for production of cartridges, blank cartridges and warheads for the *Nike-Hercules* missile.

$1,118,213—**Radio Corp. of America, Defense Electronic div.**, Moorestown, N.J., for the TRADEX program on Roi Amur, Kwajalein Island chain, a part of the Pacific missile tracking range

$678,000—**Aircraft Armaments, Inc.**, Cockeysville, Md., for design, manufacture, installation, and maintenance of a direct-fire simulation system for use with the *Anti-Tank Guided Missile.*

INDUSTRY

$1,000,000—**Thiokol Chemical Corp.**, Elkton, Md., from **North American Aviation, Space and Information Systems Div.**, for design and construction of solid-propellant tower jettison motor for *Apollo* program.

$370,000—**Fairchild Semiconductor**, Mountain View, Calif., from **Boeing Co.**, for transistors for use in the *Minuteman* weapon system.

NAVY

$5,603,000—**Raytheon Co.**, Chelmsford, Mass., for fire control radars for the *Tartar* missile system.

$3,730,000—**Northern Ordnance, Inc.**, Minneapolis, for launching systems for *Tartar* missiles.

$1,092,435—**Hercules Powder Co.**, Wilmington, Del., for plant equipment at Rocket Center, W. Va., to be used in connection with the *Polaris* propellant development program.

$1,000,000—**Guidance Technology, Inc.**, Santa Monica, for roll reference gyros for the *Bullpup* missile.

$697,380—**Vitro Laboratories**, Silver Spring, Md., for system engineering and related services connected with installation, checkout and test, and a training program for the *Terrier* missile.

NASA

$1,600,000—**Ling-Temco-Vought, Inc., Astronautics div.**, for blockhouse and ground support equipment for the *Scout* launch facility at the Pacific Missile Range.

$171,495—**The Marquardt Corp.**, Van Nuys, Calif., for a study of space rocket-engine chamber cooling techniques.

The Industry Week

News of Mergers and Acquisitions

Bissett-Berman Corp., Santa Monica, Calif., acquired Hytech Corp., San Diego, manufacturer of instrument systems and components for oceanographic research. B-B does R&D of electronic systems and equipment for military and space applications. Hytech will operate as a divisional unit of the parent company. . . . *Ortronix Inc., Orlando, Fla., acquired Metro, Inc., Detroit. Metro, to operate as a division of Ortronix, will design and fabricate mobile and air-transportable military vans, trailers, and equipment shelters. The division will be moved to Orlando and housed in a new building now under construction.* . . . Technical Operations, Inc., and Beckman & Whitley, Inc., stockholders approved a proposed merger agreement. B&W will become a wholly-owned subsidiary of Tech Ops, a Burlington, Mass., diversified R&D organization. A Tech Ops spokesmen said: "Both companies are engaged in closely related research and product activities in shock phenomena, detonation devices, photography and meteorology. By combining our efforts we gain new growth potentials for research and development and for expansion of product lines." . . . *Air Products and Chemicals, Inc., Allentown, Pa., acquired The Balbach Co., Omaha, Neb., distributor and manufacturer of industrial gases and cutting and welding equipment. Balbach will become a division of the parent company, which says the acquisition should materially strengthen company activities in the Midwest.* . . . Electro Impulse Laboratory, Inc., Red Bank, N.J., acquired controlling interest in Howard Instrument Co., manufacturer of digital instrumentation. . . . *Greer Marine, former division of General American Transportation Corp., Chicago, became a division of Fuller Co., a GATC subsidiary.*

New Industry Facilities

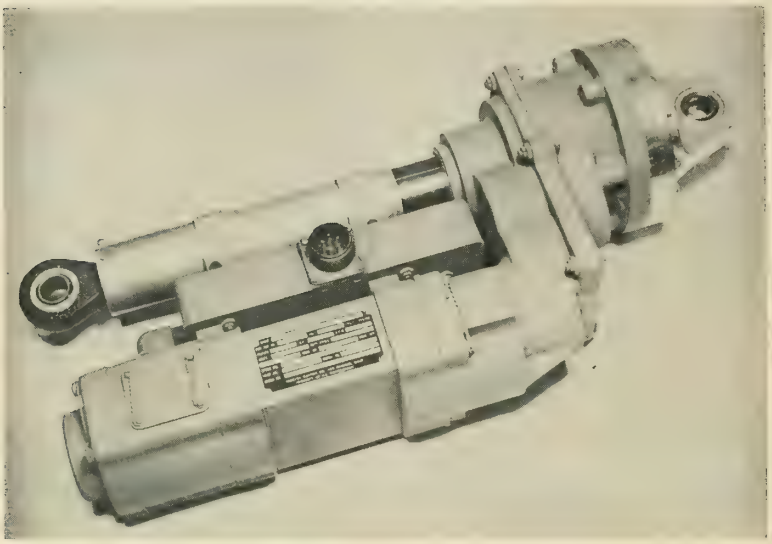
Tison-Pease, Inc., Los Angeles manufacturer of electronics equipment for missile base ground control and training systems, has opened a new 7000-sq.-ft. plant facility. . . . *American Electronics, Inc., will complete movement this month of its Instrument Division from Culver City, Calif., to the company's new headquarters facilities in Fullerton, Calif.* . . . Webb and Knapp will break ground within the next two months for the World's Aviation, Space and Communications Center in Washington, D.C. The $70-million project will contain five buildings, including twin nine-story aviation and space buildings designed to house national headquarters for aerospace industry firms. Provisions have been made for handling all confidential and secret work. . . . *Space Technology Labs, Inc., began operation of a high-vacuum chamber capable of simulating vacuums found between 500 and 800 miles altitude.* . . . Air Industries of California, manufacturers of high-performance fasteners for the aerospace industry, moved to a new 50,000-sq.-ft. plant in Gardena, Calif. . . . *General Dynamics/Electronics occupied new production labs for its CHARACTRON Shaped Beam Tubes.* . . . The Curtiss-Wright Corp. established a regional office in Huntsville, Ala. . . . *Fuller Co. will build a $350,000 addition to its Catasauqua, Pa., plant. Fifty employees will be added.* . . . The Thomas & Betts Co., Inc., began construction of a 67,000-sq.-ft. building in Elizabeth, N.J., as part of the company's expansion plans. T&B makes electrical fittings and connectors used in the aerospace industry. . . . Federal-Mogul-Bower Bearing Inc.'s Bower Roller Bearing Div. plans a 64,000-sq.-ft. addition to its Detroit plant to extend its capacity for manufacturing missile and aircraft bearings. . . . *Telemetrics, Inc., expanded its Gardena, Calif., facilities.* . . . International Resistance Co. will expand its St. Petersburg Division to increase production of precision trimming potentiometers.

International News Briefs

General Precision, Inc., and Mitsubishi Electric Manufacturing Co.; Japan, formed Mitsubishi Precision, Inc., to make electronic and precision equipment in Japan. An agreement, covering 15 years with provision for extension, calls for full reciprocal exchange of all present and future know-how, subject to national security regulations of both Japan and the U.S. Products to be manufactured and marketed include: GP computers and data processors, GP avionic systems and components, and Doppler navigation equipment. . . . *United Aircraft Products, Inc., Dayton, Ohio, and Marston Excelsion, Ltd., Wolverhampton, England, completed a cross-licensing agreement pertaining to some models of heat exchangers designed by each firm.* . . . Kawecki Chemical Co., producer of rare metals and chemicals, and Durham Chemical Group Ltd., agreed to form a joint enterprise at Birtley, England, to produce master alloys for the aluminum and high-temperature metallurgical industries. The two companies will be equal partners, with Durham, an English firm active in the metallurgical and inorganic chemical fields, operating the new concern.

New Names in the Industry

Data Science Corp. has been formed in San Diego, Calif., as an electronics firm specializing in engineering and manufacturing of digital devices and data logging, acquisition, conversion, and transmission systems. President is Ralph G. Monsees, former head of General Dynamics Advanced Products Dept. The company also offers aerospace contractors design of electronics and electromechanical circuits or systems and manufacture of required hardware. . . . *Western Electrodynamics Co. was formed at Colorado Springs Colo., to produce electronic measuring and testing equipment, electrical standards equipment, control devices, electronic instruments and scientific apparatus. Founder is Claude M. Hathaway, who will direct research and development projects. The company is building a 30,000-sq.-ft. plant, scheduled for completion this summer.*



New Product of the Week:
Linear Power Actuator

The Hoover Electric Co. is marketing its Model D-2460 high-load lightweight linear power actuator. This unit utilizes a 115-volt, 60 a-c single-phase-series-type motor, and operates under a normal load of 10,000 lbs. at a rate of 0.250 in./sec. The maximum operating load is 25,000 lbs. Basic stroke is 2.75 in.; this can be lengthened or shortened to suit individual requirements. Motors for 400-cycle operation, single or polyphase or 28-volt d-c, and other voltages are available.

The actuator has an electro-magnetic clutch-brake for low overtravel and irreversibility (this also provides the actuator with irreversibility under all non-operating and proof loads), adjustable travel limit switches, dust shield over the jackscrew, integral thermal overload protection, Helco-designed self-centering, self-lubricating modified Acme thread form on jackscrew (provides long life-minimum end play), self-aligning fittings, and positive non-jamming mechanical travel stops.

Circle No. 225 on Subscriber Service Card

Subminiature Cable Plug

Sealectro Corp., announces a new ConheX subminiature r.f. right-angle cable plug featuring a built-in test jack that permits test measurements from the center conductor of the cable without disturbing the connected circuitry. It is designed for 50- or 75-ohm impedance cable and connections, and that optimum impedance is maintained throughout the right-angle conductor path and the tap-off for the test jack.

Circle No. 226 on Subscriber Service Card

Snap-Action Attenuators

A series of compact, snap-action attenuators have been introduced by MCS Corp. They are capable of providing any factory-set value of attenuation, from 0—40db. A ¼ turn of the knurled index knob automatically inserts the attenuating element, removing guesswork. When adjusted to its maximum value of attenuation, the drive knob automatically locks in place, preventing accidental movement.

Circle No. 227 on Subscriber Service Card

Hydraulic Pumps

Parker Aircraft has developed a hydraulic pump for high-speed, high-temperature applications. Development tests have proved the suitability of direct turbine drives at speeds up to 50,000 RPM with fluid temperatures over 400°F. Life expectancy is far in excess of typical missile requirements, offering high reliability and the capability of repeated system checks. Speeds up to 60,000 RPM can be obtained in the lower flow ranges.

Circle No. 228 on Subscriber Service Card

Rotary Potentiometer

High power and high-temperature stability are combined in the new subminiature rotary-type potentiometer introduced by Daystrom, Potentiometer Division. The unit case measures only

½ in. x $1\frac{1}{32}$ in., operates up to 250°C and dissipates 3 watts in still air at 50°C.

Standard resistance values range from 10 ohms to 50 kilohms. Available with or without stops, and in all panel mounting modes, it exceeds all applicable MIL specs.

Circle No. 229 on Subscriber Service Card

C Band Amplifiers

Lightweight C-band traveling-wave tube amplifiers with a guaranteed maximum noise figure of less than 7 db are now available from General Electric Co.

These tubes feature permanent-magnet focusing and metal-ceramic construction. They are built to withstand shock up to 30 g and vibration of at least 5 g, and can operate over wide temperature ranges without variation in performance.

These low-noise tubes are furnished as completely packaged assemblies, in-

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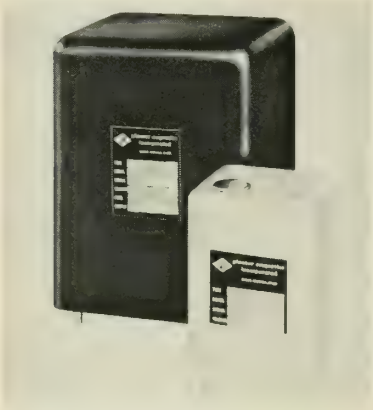
cluding permanent focusing magnets, r-f and d-c connectors and housing. Approximate package dimensions are 9.25 x 4.5 x 3 in., and weight is 11.5 lbs.

Circle No. 230 on Subscriber Service Card

Voltage Converters

A line of ultra-precision expanded scale megacycle frequency-to-analog voltage converters is being produced by Pioneer Magnetics Inc. Conversion accuracies of ±0.1% and ±0.01% of full scale are available in standard units with negligible environmental drift. The



unit is a completely static, self-contained precision detector which converts a pulse rate to a directly proportioned d-c voltage or current, and by means of an integral zero suppression circuit furnishes a zero-to-full-scale output signal over a selected narrow-input signal frequency range.

Circle No. 231 on Subscriber Service Card

Sensitive Voltmeter

Landsverk Electrometer Co. announces its model L-90 Electrostatic Voltmeter, designed to fulfill the long search for a sensitive instrument to measure high insulation leakage and the ion content of liquids.

Contained in a case measuring 7 in. x 7 in. x 9 in., it weighs only slightly more than six pounds, making it a convenient battery-powered portable instrument accurate to within approximately one volt. It measures both positive and negative input, with resistance running 10^{17} ohms minimum. Input capacity is established at 10 uff maximum.

Circle No. 232 on Subscriber Service Card

Compensated Thermocouple

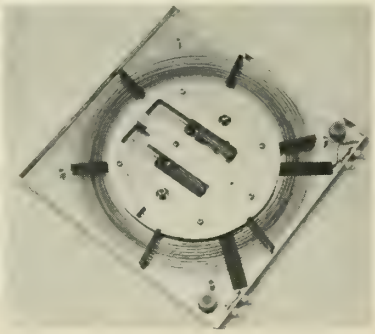
Trans-Sonics, Inc., announces the availability of a thermocouple transducer which provides its own cold-junction reference compensation.

The transducer's body contains a platinum resistance temperature sensor placed in close proximity to chromel-copper and alumel-copper junctions. The output of the platinum element is used to compensate the output from the exposed chromel-alumel thermocouple. Capable of operation over the —400°F to +1500°F range, the unit is designed with airborne applications in mind.

Circle No. 233 on Subscriber Service Card

Wire Sonic Delay Lines

Wire sonic delay lines are available from Specialty Devices Operation, Gen-



eral Electric Co., for assured operation in severe military vibration and shock environments. They can be designed for a tested capability of 50 g's shock or more, and 20 g's vibration from 20 to 2000 cycles.

Circle No. 234 on Subscriber Service Card

Heatless Seal Rectifiers

A hermetic sealing process in silicon rectifiers has been introduced by Transitron Electronic Corp. The cap and base are joined by the "cold flow" of copper into steel as the parts are forced together under high pressure. These rectifiers meet all required military and industrial tests for moisture resistance and hermeticity.

Circle No. 235 on Subscriber Service Card

new literature

RELAYS, MODULES, SENSORS — HI-G has available a 40-page Catalog No. 861 featuring its standard line of balanced armature relays, solid-state timing modules, fixed-delay and adjustable-delay electronic time-delay relays, voltage sensors, and a special customer-designed line of electronic packages or assemblies. All catalog items are presented with complete electrical and environmental specifications, electrical diagrams and drawings of header and enclosure styles available.

Circle No. 200 on Subscriber Service Card

COMPONENT COATING—A line of automatic equipment for high-production coating of electrical and electronic components is described and illustrated in a new brochure available from Conforming Matrix Corp. Included are a remote masking spray coater, a powdered-resin-coating machine, automatic tray loading machine and magazine loader.

Circle No. 201 on Subscriber Service Card

AMPLIFIER BROCHURE—A brochure is now available on Military and Computer Electronics Corp. (MACE Corp.) The company designs and manufactures a broad line of low-level magnetic amplifiers, servo and power amplifiers, toroidal pulse transformers —in military, reduced military, and industrial classifications. The eight-page, two-color brochure covers products, engineering, quality control and facilities, as well as background on key personnel. It is designed for mounting in standard size loose-leaf binders.

Circle No. 202 on Subscriber Service Card

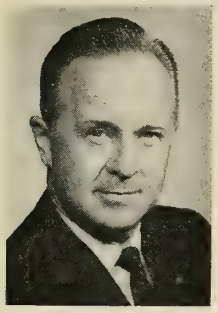
ELECTRON TUBE CATALOG — A new 24-page, illustrated, 1962 Electron Tube Condensed Catalog, featuring 65 new products, is available through Litton Industries' Electron Tube Div. Quick-reference specifications and photographs describe most of Litton's unclassified microwave tubes, display devices and operational accessories—including magnetrons, klystrons, traveling wave tubes, millimeter wave tubes, switch tubes, cathode ray tubes, fiber optic tubes, M-BWO's, and crossed-field forward-wave amplifiers.

Circle No. 203 on Subscriber Service Card

DIGITAL INSTRUMENTS — Specification sheets which give complete information on the company's new Series 800 all-electronic, four- and five-digit, AC/DC digital voltmeters, ratiometers and ohmmeters are now available from Electro Instruments, Inc. The five sheets discuss the operation, features, mechanical and electrical specifications.

Circle No. 204 on Subscriber Service Card

names in the news



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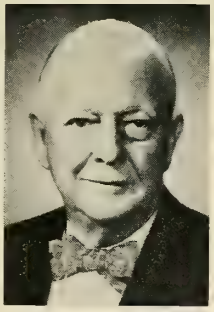

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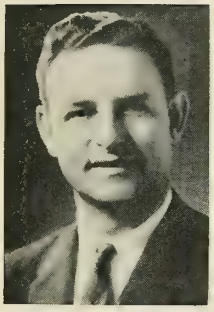

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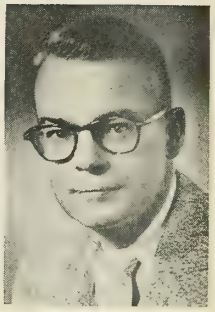


THOMAS

Don Fairchilds: In the newly created post of public relations manager at Ryan Aeronautical Co., San Diego, will supervise advertising, public relations, special programs and the public relations office at the Kearny Mesa electronics facility.

Frederick Gowen: Promoted to vice president-engineering of the R. E. Darling Co., Inc., Bethesda, Md.

Philip P. Johnston: Named vice president-planning for Ametek, Inc., New York City.

J. Thomas Pitts: Will succeed **O. B. Wilson** as vice president-marketing of the Industrial Products Group of Minneapolis-Honeywell Regulator Co. At the same time, **Robert B. Grant** will replace Pitts as sales manager of the Brown Instruments Division.

Dan A. Kimball: Elected to the board of directors of Hycon Manufacturing Co., Monrovia, Calif. Kimball is president of Aerojet-General Corp. and chairman of the Aerospace Industries Association.

Richard A. Derus: Joins Alto Scientific Company, Palo Alto, Calif. as vice president, and will assume an active role in new-product development for industrial and military marketing.

Gen. C. Pierre Cabell, USAF (Ret.): Former deputy director of CIA, has joined the Bissett-Berman Corp., Santa Monica, Calif., as a consultant on long-range development planning and technical guidance in the general field of information requirements.

Gerald J. Hogan and **Harlan S. Hosler:** Manufacturing manager and Washington office manager/assistant vice president, respectively, have been elected vice presidents of the Kaman Aircraft Corp., Bloomfield, Conn.

Owen F. Walker: Partner in the Cleveland law firm of Thompson, Hine and Flory, was elected to the board of directors of PneumoDynamics Corp., Cleveland. Re-elected to the board were **Sam S. Mullin** as chairman, **John J. Brogan, Gerard A. Fulham,** and **Tad Stanwick,** all of whom are associated with the company; and **John L. Arnold,** partner, Estabrook and Co., **Charles H. Dyson,** chairman, the Dyson-Kissner Corp., **Blancke Noyes,** partner, Hemphill, Noyes & Co., **Joseph J. O'Connell,** partner, Chapman, Walsh & O'Connell, and **Allan K. Shaw,** vice president, the Cleveland Trust Co.

Alfred A. Goldberg: Will be responsible for commercial and military sales and marketing program of stabilized d-c power supplies and systems for Power Designs, Inc., Westbury, N.Y., in his new position of vice president-sales.

Russell E. Bauer: Named to the office of vice president-electronics and servo systems group of Ex-Cell-O Corp., Detroit.

Herbert E. Peitzer: Promoted to vice president of the Engineering Divisions of Arde Inc. in Newark, N.J., and Huntsville, Ala.

Robert C. Rosaler: Appointed vice president and general manager of M. ten Bosch, Inc., Pleasantville, N.Y.

Victor J. Pollock: Brought into Leach Corporation, Compton, Calif., as financial vice president and treasurer.

Dr. Wernher von Braun: Director of the Marshall Space Flight Center, was recently awarded the French Order of Merit for work in the field of research and invention. Other scientists honored at the same time included **Professors Hermann Oberth** and **Eugene Sanger,** and **Doctors Theodore von Karman** and **Frank Malina.**

J. M. Cumming, J. E. Kendall, and **S. J. Domokos:** Named general manager of Space Engines, assistant general manager and acting manager of Space Engines Manufacturing, and chief engineer, respectively, of Rocketdyne, a division of North American Aviation, Inc.

Capt. E. N. Dingley, Jr., USNR (Ret.): With the Advanced Development Laboratory of Electronic Communications, Inc., St. Petersburg, Fla., appointed chairman of the International Administrative Committee of the IRE Professional Group for Military Electronics.

W. E. Thomas: Former executive vice president and a member of the board of directors, has been made president of Magnaflux Corp., Chicago, a subsidiary of General Mills.

W. R. Kiefer: In his new position as corporate director of materiel, Ling-Temco-Vought, Inc., will formulate policies for the procurement of more than $100 million annually in material and equipment.

Douglas D. Danforth: General manager of the Westinghouse Electric Corporation's control division, has been elected a vice president of the company.

William A. McCracken: Will fill the newly created position of vice president-operations of the General Instrument Corp., capacitor division, Newark, N.J.

J. Walton Colvin: Named manager of plans and programs for General Dynamics/Electronics-San Diego.

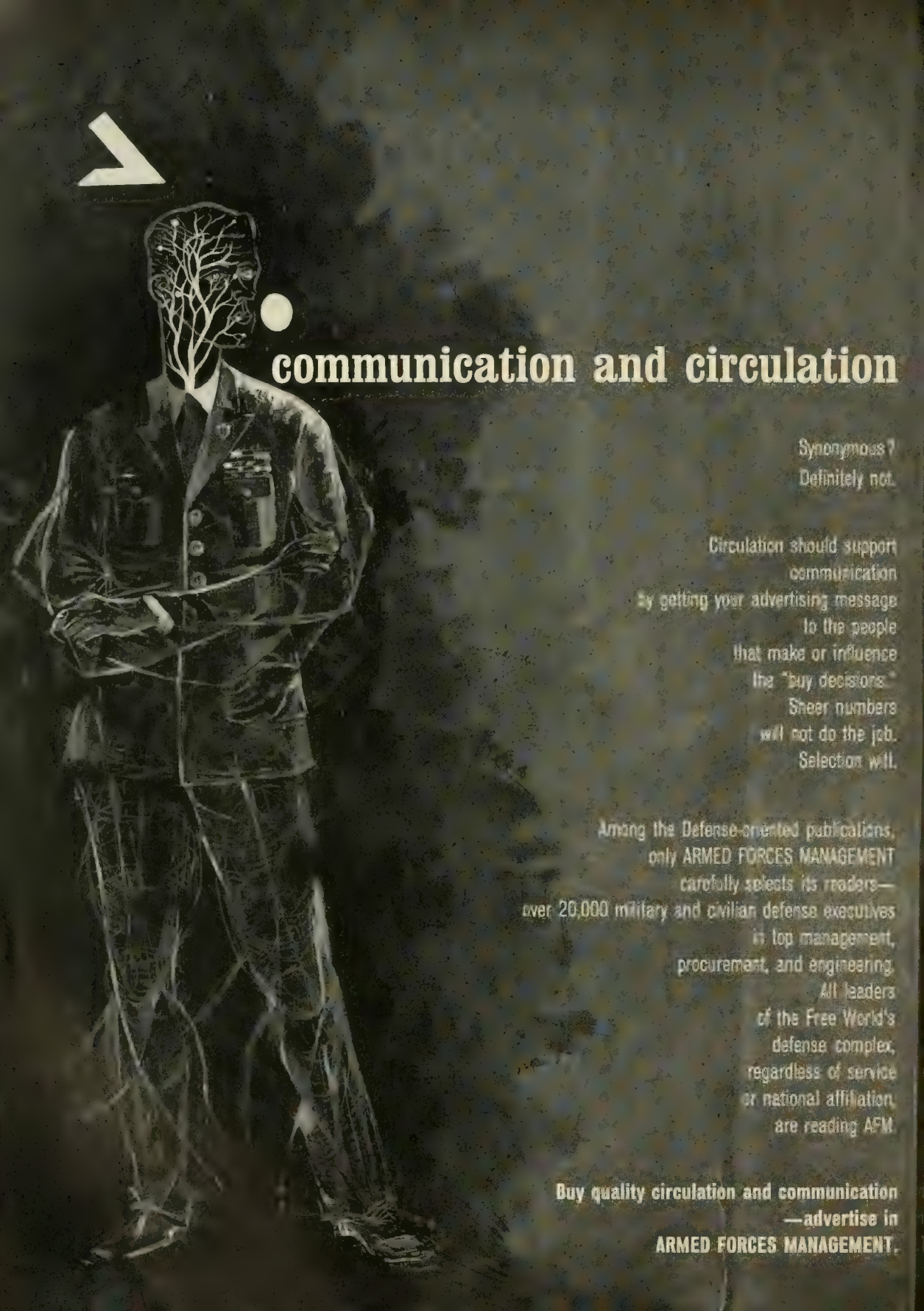
Dr. James C. Hodge: Former executive vice president, was elected president of the Warner & Swasey Co., Cleveland. **Walter K. Bailey,** who has served as president, was made chairman of the board and chief executive officer.

Donald P. LeGalley: Scientific Staff consultant for Space Technology Laboratories, Los Angeles, has been appointed the 1962 chairman of the American Rocket Society Guidance and Control Committee.

Moody Besancon: Will occupy the position of vice president-administration, eastern region, of Babcock Electronics Corp., with offices in Washington, D.C. **Lester R. Ross** was made his assistant.

F. Charles Ruling: Named head of General Electric Company's new Aerospace and Defense Marketing Operation; **Lionel H. Naum** will lead a new Program and Public Information Operation.

Fred A. Peters: Has joined California Computer Products, Inc., Downey, Calif., as administrative assistant to the vice president and chief engineer.



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—when and where—

Second Conference on Kinetics, Equilibria and Performance of High-Temperature Systems, sponsored by the Western States Section of the Combustion Institute, University of California, Los Angeles, April 16-18.

American Society for Metals, Regional Conference and Exhibition, Shamrock Hilton Hotel, Houston, April 17-19.

International Symposium on Rocket and Satellite Meteorology, sponsored by World Meteorological Organization, International Union of Geodesy and Geophysics and Committee on Space Research, Department of Interior Auditorium, Washington, D.C., April 23-25.

American Physical Society, American Institute of Physics, Sheraton-Park Hotel, Washington, D.C., April 23-26.

Materials Handling Conference, American Institute of Electrical Engineers, Pick-Carter Hotel, Cleveland, April 24-25.

Electromagnetic Relay Conference, Oklahoma State University, Stillwater, April 24-26.

American Institute of Electrical Engineers, Great Lakes District Meeting, Hotel Van Orman, Fort Wayne, Ind., April 25-27.

Western Space Age Industries and Engineering Exposition and Conferences, Cow Palace, San Francisco, April 25-29.

International Symposium on the Use of Artificial Satellites for Geodesy, sponsored by International Association of Geodesy and Committee on Space Research, U.S. Naval Observatory, Washington, D.C., April 26-28.

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Those Lush Defense Profits

WE ARE DEEPLY CONCERNED over damage to the industry which may result from the current Senate profit hearings.

We certainly do not question the right of the Senate Permanent Investigations Subcommittee to probe into profits on missile contracts. The subcommittee, in fact, has been careful to give the contractors concerned a full and immediate opportunity to comment on the figures.

Nor do we intend to discuss here the question of whether the specific profits involved, made by Douglas Aircraft Co. and others, were excessive. That is a matter for the committee to determine.

But we do want to discuss the quick and widespread acceptance of the implication that because the profits were large they probably were excessive.

This is a reflection of what Lockheed Chairman Courtlandt S. Gross has called the "hostility to fair and adequate profit from defense work."

For some reason, the attitude persists that companies involved in the defense business are making vast profits on armament. Yet aggregate net income of Aerospace Industries Association members after taxes is reported as 1.8 cents on the sales dollar in 1961.

Indeed, this low level of profit makes many firms reluctant to participate in defense business, with its many controls and restrictive practices. Martin Co. President William B. Bergen puts it this way: "It is certainly no secret that the profit margins of defense contractors are considered by analysts to be a deficiency of the defense industry."

This does not mean, as Bergen pointed out, that a firm cannot make a reasonable profit in this business. But that reasonable profit frequently is achieved against long odds.

There is too little realization that the fees made on a single program often are spread over other necessary expenditures that significantly reduce what a company reports as profit. It is this exercise in semantics that is confusing many in the current hearings.

It is not necessarily the cost performance of a company on a single program that most benefits the nation. It is the ability of that company to maintain its overall capability, its willingness to devote engineering skills and facilities to advanced programs which are not as yet income-producers.

This is where the defense contractor differs from other businessmen. Comparisons in the Senate hearings to conventional activities such as home-building are misleading. A housing contractor is seeking the highest possible profit margin he can obtain on the house he currently is building.

The defense contractor must concern himself with the next contract, with problems to which the military is seeking a solution, with advancements in technology.

"The defense contractor's backlog may look beautiful today, but if he is not building advanced skills and technologies, if he is not studying the customer's future needs, then he is certainly headed for trouble at some point in the future," says Martin's Bergen.

On a single program, Lockheed once was precontractually exposed to the extent of $26 million. The firm has provided more than $81 million in private funds for facilities in its Missiles and Space Co. Martin in a recent year spent $500,000 on materials research alone.

These are not financial activities which are covered in the funding of any single program. The money for these must come out of the fees paid on many programs. Profit is what the company then has left over.

It is ironic, in a sense, that Douglas Aircraft bore the brunt of profiteering charges in the early days of the hearings. The company has been in serious financial difficulty. Douglas profit on 1961 total sales was enough to make any security analyst shudder—less than 1 percent. In 1959 and 1960, it lost $53 million. Book value of Douglas stock has dropped from $40 to less than $33. Its stockholders have not received a dividend in three years.

It's a strange form of profiteering.

THE CHARGE of lush profits on subcontracted work will, we are certain, lead to suggestions that the government should handle its own subcontracts to eliminate the "middleman." Yet it is germane to ask what might have happened if such were the case on the *Nike-Zeus* program. The Army, setting out on such a course, probably would have found it did not have sufficient personnel with the necessary technical management skill. Civil service pay scales would have precluded hiring qualified systems management engineers. Next step would have been to a nonprofit corporation to manage the program. We suggest that the cost of that operation might have been considerably more than the fees paid to Douglas and others to do the same job—and do it faster and more efficiently.

We suspect company president Donald Douglas, Jr., is remembering with cause a speech he made last October in California. He said then:

"While there is always room for improvement, I think our defense industries are trying to do a responsible job. Our task is to advance these efforts—not to throw brickbats. And one of the most important things we can do is clarify for defense industry just what our philosophy is concerning its place in our national life."

We hope the result of the Senate hearings will be, not merely vilification, but that clarification.

William J. Coughlin

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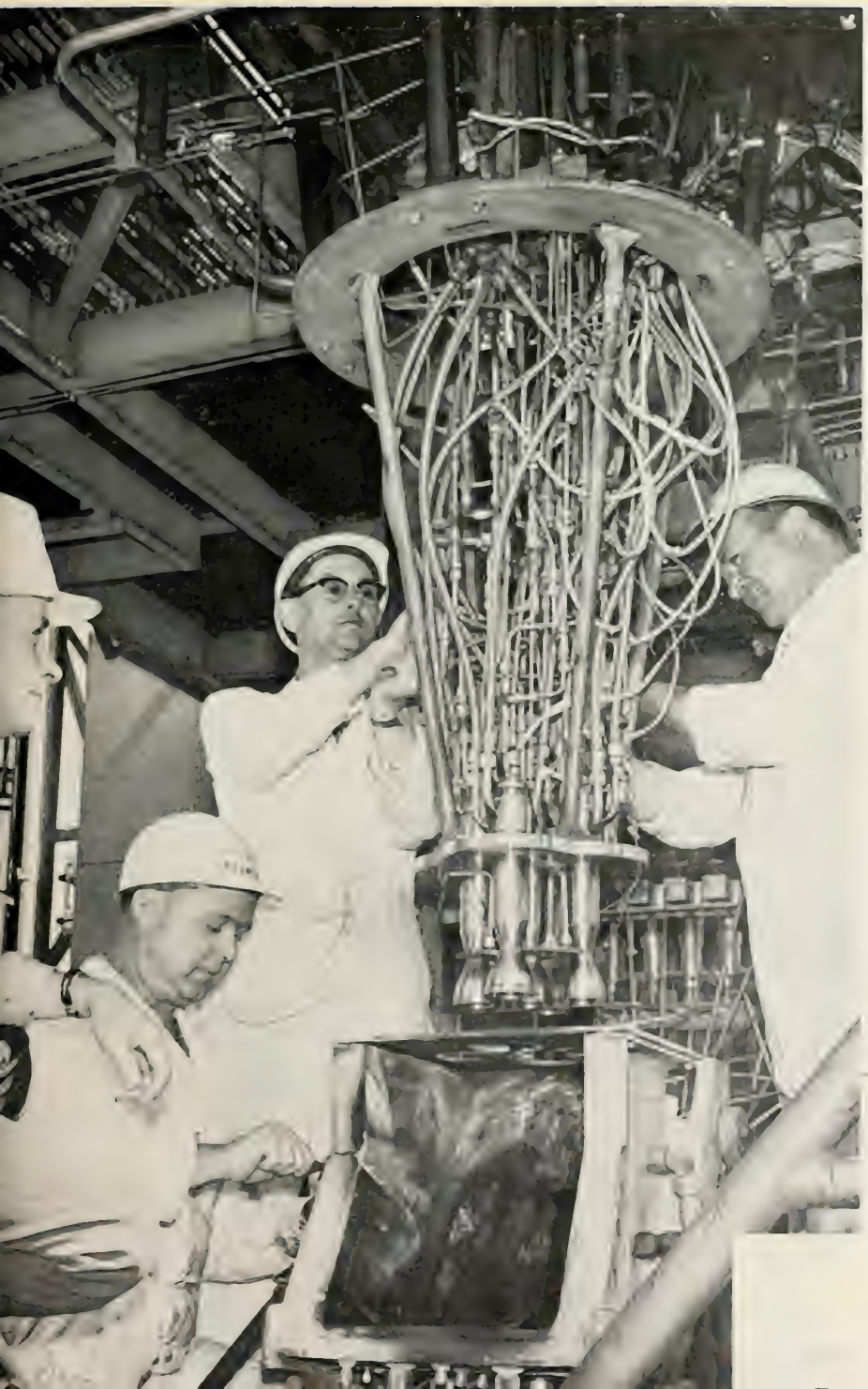
APRIL 23, 1962

missiles and rockets

THE WEEKLY OF SPACE SYSTEMS ENGINEERING

Houston, Texas



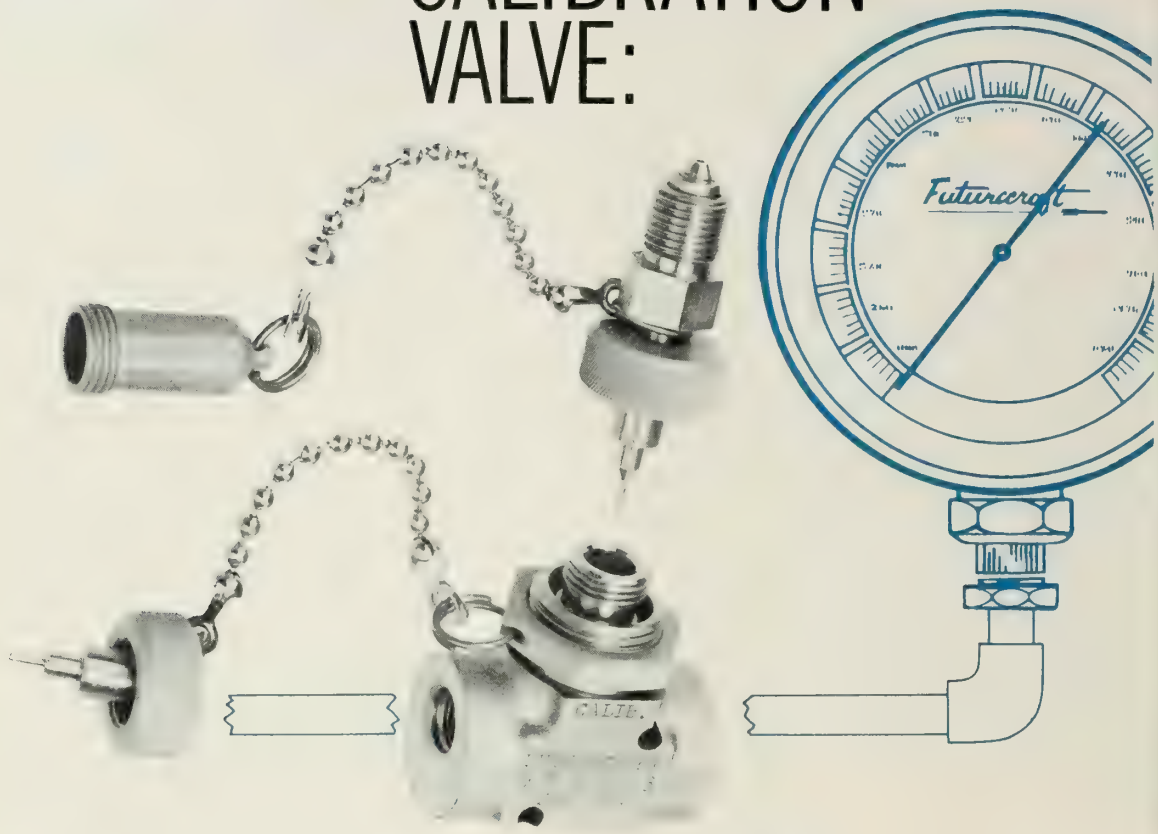
U.S. Will Build New 'Aerospace' Plane in 1965

- Nike Prime Defends Profits
- Apollo Up for Systems Review
- NASA Builds IMP Satellites

Saturn C-5 Model Engines

AN AMERICAN AVIATION PUBLICATION

FUTURECRAFT CALIBRATION VALVE:



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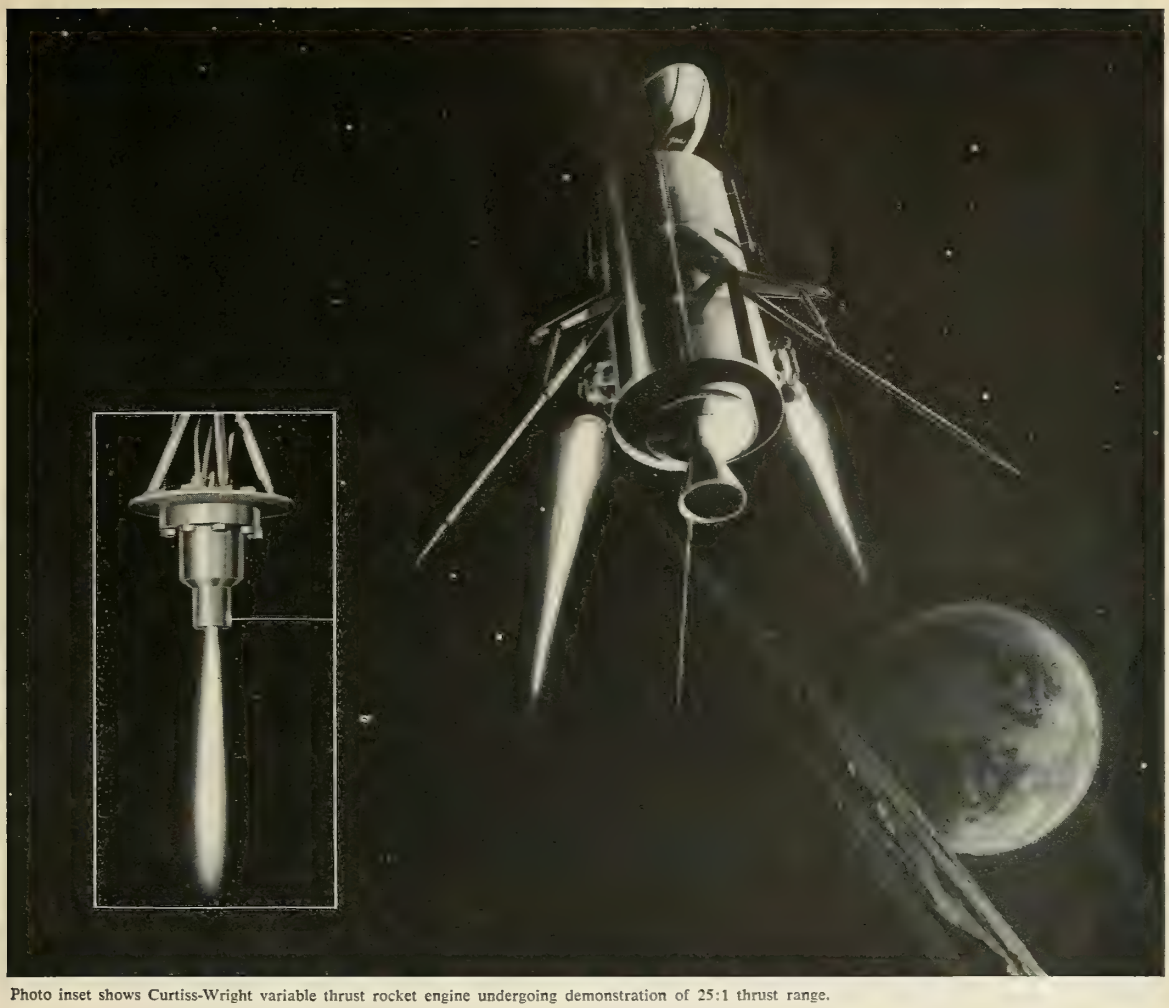

Photo inset shows Curtiss-Wright variable thrust rocket engine undergoing demonstration of 25:1 thrust range.

Major New Developments in Small Rocket Engines

At Curtiss-Wright, a large engineering team is placing emphasis on new concepts and techniques for small rocket engines for attitude and vernier control.

Variable thrust rocket engines provide thrusts ranging from 10 to 1500 pounds, with a proven 25:1 thrust ratio. Suitable for both control and propulsion of space vehicles, these powerplants provide high impulse and efficiency, are throttleable and can be shut-off and started in flight.

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Further development, testing and fabrication of prototype engines is now being conducted at Wright Aeronautical Division under several contracts from the U. S. Air Force and NASA.

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THE WEEKLY OF SPACE SYSTEMS ENGINEERING

missiles and rockets

Volume 10, Number 17 April 23, 1962

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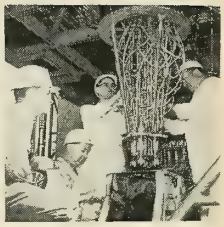
THE COVER

NASA technicians ready a scale model of a five-F-1-engine cluster for static test firing. A "real" F-1 cluster will power Saturn C-5 lunar launch vehicle. A Saturn shot is due this week. See story on p. 13.



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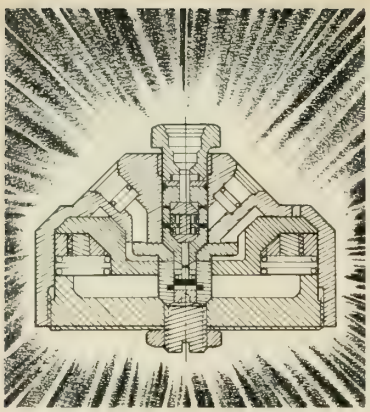

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letters

Counter Rebuttal

To the Editor:

Mr. D. L. Leavitt's exception (Letters, M/R, April 2) to my position (Letters, Feb. 26) regarding the DOD policy of permitting military contractors to retain commercial rights in inventions arising out of the performance of R&D contracts is forcefully expressed.

My objection to the DOD policy is that it is indiscriminate because it permits military contractors to retain commercial rights in inventions without regard to what the contractor does with the invention.

Mr. Leavitt fails to distinguish between two distinct problems relating to inventions which a company encounters when it does business with the military.

When a company accepts an R&D contract, the problem at once arises as to how it can protect inventions, trade secrets and know-how developed or acquired entirely with its own funds from appropriation by the government as an incident to the contract. The government's contract practices tend to force the R&D contractor to reveal proprietary information in reports, drawings, and other data forms.

Dissemination of that information, in turn, tends to remove the advantage obtained through a company's own ingenuity and raises other contractors having access to the data to the same technological level. A company having many R&D contracts may eventually surrender all its proprietary information.

The second problem concerns the patent rights in an invention made in the performance of the contract. Where the invention has only military utility, the government—because it has secured a license under the invention for governmental purposes—obtains all the valuable rights in the invention and no patent rights of consequence remain with the contractor. When the invention also has commercial uses, the contractor under present DOD policy retains commercial rights. It is around the commercial rights that the battle between the government and the big military contractors swirls.

Many contractors maintain that commercial rights should stay with the contractor, on the premise that the military's interests are entirely protected by its license to use the invention freely for governmental purposes. That position ignores the fact that the incentive for the invention was the performance of an R&D contract —not the desire to produce a commercial product. That position overlooks the ways in which commercial rights in a patented invention may be used.

Such rights can be used to prevent competitors from copying a new commercial product. This inhibits competitors' forcing the price down, and thereby enables the pioneering company to recover the costs incurred in developing the item, distributing it and advertising it. To use commercial rights to nurture a new product is to use those rights constructively.

Commercial rights can also be employed obstructively. Recognizing that an invention has potential commercial uses, a contractor may patent it, and wait. When someone wants to use, or has unwittingly used, the invention in a commercial product, the contractor can demand that a license under its patent be purchased. That manner of using a patent is obviously destructive. It taxes the initiative of those who would commercially use the invention, while not requiring the contractor to do anything but patent it.

Recent surveys have indicated that 7% to 13% of the R&D inventions patented by contractors are used in commercial products made by the contractors or their licensees. In contrast, where inventions are financed entirely with company funds, over half those inventions are used in commercial products. From this, it is evident that a company does not have the same incentive to exploit an invention arising out of an R&D contract as it has when the invention is paid for out of the company's own funds.

Should the DOD permit a contractor to obtain commercial rights in inventions arising out of R&D contracts without placing him under an obligation to use those rights constructively?

Louis L. Orenbuch
Boston

Trend in Exhibits

To the Editor:

Thank you very much for your report of the Aerospace Industries Association survey of exhibit plans ("Survey Shows Firms Cutting Exhibit Plans," M/R, April 2, p. 38). This will help to guide us

The Lights of Perth—II

Before me dance the gleaming Pleiades
And bright Orion strides
across the sky.
Long have the sailors on
terrestrial seas
Prayed for their light to steer
a vessel by.
A newer ocean bathes my little boat
Above the moon-drenched clouds—
but as of old
The stars remain. Dark is the land,
remote
Along the shore no lighthouse.
But behold!
That patterned light, that beacon
on the strand
By strangers lit to guide a mariner
And signal friendship. Rejoice my
heart and,
After thanking God Who filled
with stars
The heavens on the dark side of
the earth,
Thank everybody for the
lights of Perth.

J. P. Davis
Nuclear Engineer
Burns & Roe, Inc.
New York

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in our exhibit planning.

While I tend to be in sympathy with your viewpoint with regard to exhibits, I am quite intrigued to know how you managed to establish a "downward trend" from a single observation in time. Whatever your technique is, it could be the greatest contribution to sales forecasting since the invention of the crystal ball.

Nathaniel R. Kidder
Manager, Marketing Services
Jack & Heintz, div. of
The Siegler Corp.
Cleveland

Space did not permit a comparison with the much heavier participation last year.—Ed.

Blames Washington

To the Editor:

I have been reading with interest for some time your editorials and the letters which your magazine evokes. Thus I feel your April 16 editorial on "Those Lush Defense Profits" might deserve discussion from an angle that is frequently by-passed.

I would certainly condemn the administrative policies of Government which bent once-ethical presentations to become the present "name-dropping" requirements for obtaining contracts. Being unable to stockpile prominent Names, the small business must continually produce efficient work to exist on subcontracting—while also shoveling excessive profits into the large, established Contractor (now called Systems Manager) who gets credit for the job.

Rather than review all cases motivating my letter, let me generalize and state that in my professional lifetime I have watched competent and needed engineers, overburdened with responsibility but understocked with authority, leave the industry because *paid* advancement on technical capability was subjugated and money advances went to those using administrative qualifications. The fact that these qualifications could be gained for such things as B-girl rationing at junket symposiums in no way altered the trend; and self-respecting engineers, unless dedicated to the point of naivete, left the industry with a bad taste in their mouths.

A most recent case in my knowledge involves the loss of a highly competent engineer well-versed in missile testing. He left a responsible job which called for broad experience to buy a liquor store and relax in Florida. Considering the "impact" cost of living and related inconveniences, he certainly cannot be blamed.

Most excessive profits can be traced to two causes, and neither of them can use paid research study contracts as a mask for improper method: Contracts Administration is favorably impressed or influenced by (1) Parties, kickbacks, or the possibilities of free publicity during election periods and (2) Long-hair advice from stockpiled Names who will probably die off before repercussions can occur. Both of these causes place the responsibility firmly in Washington, D. C.—as they have since 1935!

Bert Sands
AIRco
Eau Gallie, Fla.

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The Countdown

WASHINGTON

Pentagon Wants More Nuclear Tests

The military services—especially the Air Force—reportedly want an increase in the number of U.S. nuclear test shots scheduled to begin in the Pacific this week. They feel that the series presently planned won't provide enough proof-testing of missile warheads already in the arsenal. It's unlikely, however, that the two-to-three-month series will be extended—opposition from AEC and the White House is very strong.

Single Strategic Command?

One of Defense Secretary McNamara's most controversial reorganization proposals—a single command for strategic retaliatory forces—is far from dead, a "strictly non-attributable" Pentagon source says. When the proposal was first "leaked" last year (presumably by Navy officials fearing an AF takeover of *Polaris* control) it caused quite a fuss. But it's still very much alive—and might be implemented later this year.

Blackout May Spread to Missiles

Watch for the Administration soon to extend its news blackout on space vehicle launchings (M/R, April 16, p. 13; this issue, p. 10) to cover military missile programs as well.

NASA Budget Gets Easter Stay

The House Space Committee is expected to lop another $35 million from NASA's Fiscal '63 budget request when it returns from the congressional Easter recess. Before the holidays, the group voted to cut $85 million from the request for Manned Space Flight, including $50 million requested for *Nova*. When the committee is finished with it, the bill will go to the House floor for debate.

Tiros V Slips to June

The launch of *Tiros V* has slipped to June because of earlier delays in *Tiros IV*. The new satellite will provide coverage of over 22 million square miles. This will be accomplished by launching it northeast from Cape Canaveral and increasing its orbital inclination.

Funds Forced on Services

Improbable as it sounds, the Defense Department had to "persuade" the Air Force and Navy to include funds in their FY '63 budgets for developing chemical and biological warfare delivery systems. A DDR&E official says the two services were "unwilling to spend any money to do either development or procurement of delivery systems," but have changed their minds under DOD pressure.

SAINT To Be Tested Soon

Within the next month the Air Force is expected to launch a small payload into space, then launch its *Satellite Inspector* spacecraft to more or less "rendezvous" with it in a feasibility demonstration of the *SAINT* system. If successful, the demonstration vehicle—reportedly tied to the Lockheed *Agena* upper stage—will be the forerunner not only of a developmental model of *Inspector* but of a *Satellite Interceptor* as well.

INDUSTRY

Patent Stalemate Seen

Don't look for any major changes in NASA's patent policies to result from a House Space Subcommittee report calling for their relaxation. Legislation providing for easing the regulations has passed the House Space Committee for three years running, but the Senate Space Committee never goes along.

Aerojet Finishing Titan I Work

Aerojet-General has just about wrapped up all propulsion work for *Titan I*. As the first nine Martin *Titan I's* went operational at Lowry AFB, Colo., last week (see p. 10), Aerojet had completed its last first-stage engine for the *Titan I*. The last second stage will follow shortly. The firm's Sacramento facility is now converting its seven-acre engine assembly area to *Titan II* engine production. Incidentally, Aerojet claims it cut nearly $8 million from the proposed $40-million cost for the last 80 sets of *Titan I* engines.

Telstar TV Schedule

If AT&T's *Telstar* communications satellite launching is a success, the first transatlantic television programs will be conducted for periods of 10 or 12 minutes. The launch is slated for next month.

Latest Cape Pad Planning

NASA now plans to build four *Saturn C-5* pads at Cape Canaveral. If the Air Force agrees to ask Congress for the necessary funds, 10,000 additional acres of land will be purchased at AMR. NASA officials would then move their *Saturn* and *Nova* pads farther north, permitting the Air Force to install its *Titan III* pads in the southern end of the recent NASA land acquisition.

INTERNATIONAL

Japan-U.S. Launching At Hand

The U.S. and Japan will make their first joint space exploration this week. A *Nike-Cajun* rocket fired from Wallops Island will carry a Japanese radio frequency resonance probe supplied by Japan's Radio Research Laboratory. The joint program calls for three launches.

The Fylingdales Stretchout

Delays continue at the BMEWS station being built at Fylingdales in Yorkshire, England. Erection of the radome of the main tracker building was scheduled to be under way now, but the completion date for other work on the building has been set back a month. A group of joiners seeking an extra seven cents an hour has been on an unofficial strike for nearly three weeks.

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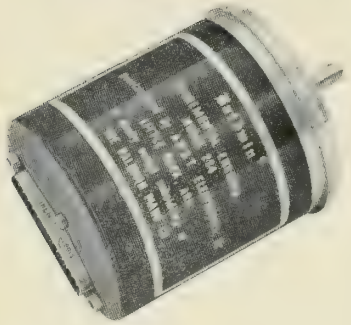

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The Missile/Space Week

Shots of the Week

The Army's *Nike-Zeus* antimissile missile was fired from Point Mugu, Calif., April 12 in a test of all three of the missile stages. All test objectives were met, according to an Army announcement.

The maneuverable third stage—designed to carry the warhead to within killing distance of its target—reached "an extremely high altitude," Army officials said. The exact altitude is classified.

Elsewhere:

• Failure of the second stage of an AF *Blue Scout* rocket to ignite resulted in the loss of a classified satellite package on April 12.

Launched from Cape Canaveral, the *Blue Scout* carried a payload of radiation experiments designed to furnish data for ARPA's *Vela Hotel* program for detecting nuclear explosions in space.

• An *Atlas* operational training launch was carried out successfully at Vandenberg AFB April 11 by a SAC combat crew from Offutt AFB's 549th Strategic Missile Squadron.

• A sodium vapor experiment was launched from NASA's Wallops Island Station April 17 by a *Nike-Cajun* sounding rocket.

Designed to study upper-air density and wind velocity, the sodium vapor was released continuously from an altitude of 26 miles to a maximum altitude of 144 miles.

• The Air Force launched a satellite with a *Thor-Agena B* combination from Vandenberg on April 17. AF officials declined to say what the satellite contained, whether it went into orbit—or even the time at which it was launched.

The lack of information, they said, was due to a DOD directive classifying information on all military satellites (M/R, Apr. 16, p. 13).

• A NATO crew successfully fired a Chrysler *Jupiter* IRBM 1500 miles down the Atlantic Missile Range from Cape Canaveral on April 18. The shot was carried out to give the troops—believed to be Turks—experience in handling the *Jupiter* system.

Titans Turned over to SAC

The first of six squadrons of Air Force Martin *Titan I* ICBM's went operational at Lowry AFB, Colo., last week.

Nine *Titans* in hardened sites were turned over to SAC. The AF said another nine would be operational within two weeks.

The Air Force opened the first *Titan I* complex for an extensive press tour before the activation ceremony, at which AFSC commander Gen. Bernard A. Schriever turned the site over to SAC commander Gen. Thomas Powers.

The nine-missile activation brought to 63 the number of operational U.S. ICBM's.

This year, six *Atlas F* silo squadrons and six *Titan I* silo squadrons will be added to the seven *Atlas* squadrons already operational — to more than triple the nation's operational ICBM force. It will be tripled again in 1963.

Titan II is scheduled to go operational next February at Davis-Monthan AFB, Tucson, Ariz.

SNAP-50 Contract Awarded

The Atomic Energy Commission has awarded Pratt & Whitney Aircraft Div. of United Aircraft Corp. a contract for design and development of the *SNAP-50* (M/R, Feb. 19) auxiliary power unit, reportedly for use in space missions in the late '60's.

During FY '63, the contract is expected to run about $3.5 million and be centered around the design, research and development of critical components of the lithium-cooled advanced nuclear reactor.

A by-product of P & W's work on the cancelled nuclear aircraft program, *SNAP-50* conceivably could be used as a power source for electrical space engines, advanced communications satellites and other sophisticated spacecraft with high power requirements. The exact power level of the *SNAP-50* device is now classified, but is in the 300-kw range.

Europeans Join In Space Effort

Seven nations — Australia, Belgium, France, West Germany, Italy, the Netherlands and Britain—have agreed on establishment of a European Satellite Launcher Development Organization, it was announced in London last week.

Under the agreement, the British would develop the first stage—based on the *Blue Streak* rocket—with the French responsible for the second stage and the West Germans the third stage.

Italy will be responsible for the design, development and construc-

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tion of the initial satellite test vehicles; Belgium for the ground guidance stations; the Netherlands for long-range telemetry links; and Australia for launch facilities at its Woomera Test Range.

The first firing of the *Blue Streak* for the European consortium is expected late next year at the Woomera range.

AFSC Management Seminar

The first AFSC Management Conference will be held at the Naval Post Graduate School, Monterey, Calif., May 2-5, AFSC Commander, Gen. Bernard A. Schriever announced last week.

The theme of the conference will be "Systems Acquisition and Management in Today's Environment." The purpose of the conference, the AF announcement said, is to permit "an exchange of views between leaders of the industrial, scientific, academic and financial management communities and General Schriever and his staff on the nature, scope and implications of the changes which have occurred over the past year in the management of the acquisition of new systems."

Five major subjects — planning for systems acquisition, source selection, procurement, financial management and systems management — have been scheduled.

Although attendance at the seminar will be by invitation only, the AF announcement said, the proceedings of the meeting will be published and will be available to anyone interested in the conference material.

Gemini Radar Award

Westinghouse Electric Corp. will develop ultra-lightweight radar for *Gemini* rendezvous.

The contract, estimated to be worth $5-10 million, was awarded by McDonnell Aircraft Corp., prime contractor for the two-man spacecraft.

N. V. Petrou, general manager of Westinghouse's Air Arm Div., said the radar unit would be used after *Gemini* went into orbit to provide steering information for visual contact with another satellite already orbiting.

Minuteman Facility Opened

A *Minuteman* missile rolled off the assembly line at the Air Force's plant 77 at Hill AFB, Utah, last week, marking the opening of the Boeing-operated production facility.

All of the more than 800 *Minuteman* ICBM's will be assembled in this plant before going to their operational sites throughout the country.

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U.S. Plans Research ASP in '65

Joint AF-NASA program would be used to develop vehicle for advancing technology for the 1970's

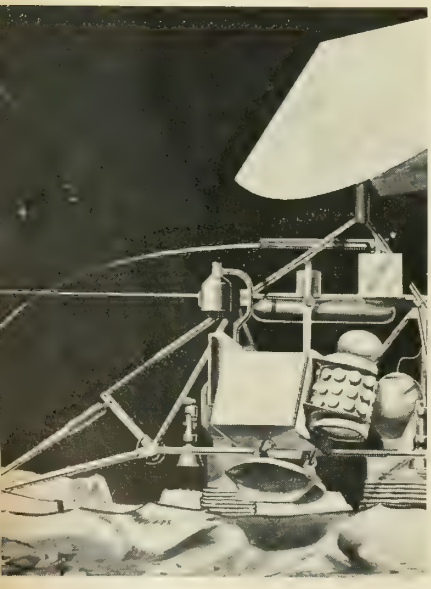
by Hal Taylor

THE U.S. EXPECTS to build an "aerospace" research plane in 1965 which will be the forerunner of future manned military spacecraft.

The new plane's development was disclosed by John Stack, Director of NASA's Office of Aeronautical Research.

Stack said the craft would be used to develop the technology for this country's post-1970 space exploration and military needs.

"We will hopefully have a pretty significant research effort to define the vehicle during the next twelve months," he said.



Surveyor on Moon

NASA'S Surveyor spacecraft is shown in first released artist's concept. The lunar-landing automatic laboratory will carry an atomic power supply (drum-shaped device near center of spacecraft) which AEC has designated Martin to develop and build.

Stack added that NASA and the Air Force have discussed the program and that 1965 was a "reasonable" time to build it.

Preliminary research indicates that the new craft will be 90 ft. long and will weigh about 100,000 lbs. It will probably be propelled by a combination powerplant called the turboram rocket. In addition to greater speed and altitude than the current *X-15* rocket plane, it will be capable of sustained cruising and earth takeoffs.

All of those requirements closely approximate the Air Force's desire for an aerospace plane which could take off from the Earth, go into orbit, and be capable of rendezvousing and even shooting down enemy satellites and spacecraft and then returning to Earth under its own power.

Stack, however, shied from saying that the new research plane would be the test-flight predecessor to the aerospace plane. "Our efforts," he said, "are necessarily in the area of expanding U.S. technology so that the use of such devices (the aerospace plane) can be more accurately defined because the planners will have the technology for making a choice."

• **New job for X-15**—Details of the new plane were revealed as NASA and the Air Force jointly announced a follow-on research program for the *X-15* in which the rocket plane will serve as a test vehicle for this country's military and civilian space programs.

The new program calls for at least 35 flights and will take up to two years to complete. Some 13 experiments will be included.

One of the most important will be an electric stick controller for possible use in manned spacecraft. Another will be an airborne letdown computer which will enable a pilot to plan his landing approach from reentry to touchdown on the ground.

Several other Air Force experiments will investigate infrared and ultraviolet data at the extremes of the *X-15's* higher-altitude capabilities.

Each engine exhaust has a different type of "signature" by which it can be detected from other engines. The U.S. hopes these experiments will provide valuable information for the detection of enemy satellites and missiles.

An experiment which will be helpful to both NASA and the Air Force calls for the testing of various possible materials which may be used as high-temperature leading edges for spacecraft.

Other experiments planned for the program include:

—A horizon scanner will be used for the study of light across the spectrum. The objective is to obtain information for accurate sensing of the horizon in order to develop improved attitude and guidance reference for navigation of manned earth-orbiting spacecraft.

—An alphatron ionization guage will be mounted in a small wing-tip pod for density measurements of the atmosphere above 100,000 ft. A similar pod will house equipment for the measurement of micrometeoroids.

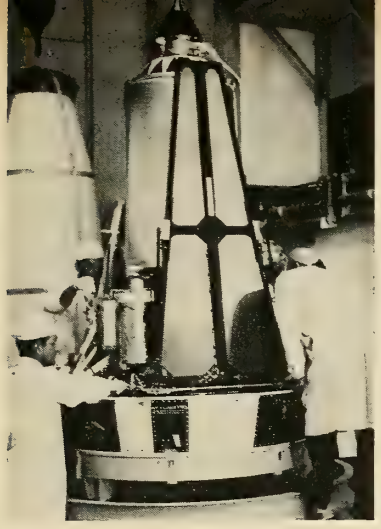
—High-temperature glass windows for spacecraft use will be tested.

• **Ultraviolet photography** — Work has started on one of the primary projects, an experiment in ultraviolet stellar photography. The University of Wisconsin, under a contract awarded by NASA's Office of Astronomy and Solar Physics, will devise and conduct the study in photographing the stars from altitudes above 40 miles.

Drs. A. D. Code and T. E. Houch of the University's Space Astronomy Laboratory hope to test current theories pertaining to the origin and make-up of stars by using this method.

On the ground and at moderate altitudes, ultraviolet rays of the sky and stars are obscured by ozone in the earth's atmosphere. Main advantage sought is the *X-15* pilot's ability to orient the aircraft to face the stars above the ozone layer, plus the aircraft's capability to return and repeat the experiment.

The instrumentation for the "star tracker" consists of a gimballed platform containing four cameras, to be mounted in the *X-15* instrumentation bay behind the cockpit. Clamshell doors atop the airplane will be opened as the airplane arches over its long ballistic trajectory and is maneuvered by the pilot to give the cameras a clear view of distant stars—thus making possible a continuous, simultaneous series of photographs in different ultraviolet wavelengths. ⠿



RANGER IV gets final adjustments by JPL technicians. Cylindrical heat shield provides thermal control for retro motor.

Ranger Shot Heads Heavy Launch Schedule

Fourth moon try set for week along with second Saturn flight, rescheduled S-51, possibly much-delayed Centaur

NASA HAS SCHEDULED a spectacular series of space shots this week highlighted by the second U.S. attempt to take pictures of the lunar surface with the *Ranger* spacecraft.

Following *Ranger* in quick succession will be the second test flight of the *Saturn* booster and the orbiting of the *S-51* international satellite.

A fourth starter is possible. The long-delayed first launch of *Centaur* was scheduled for late last week. Technical difficulties, however, could push the launch into this week, creating a real "traffic" problem at Cape Canaveral.

The "window" of the *Ranger IV* spacecraft is April 23-25. *Saturn* will follow on April 25, and the joint U.S.-British *S-51* satellite on April 27.

Of the three, *Ranger* is by far the most difficult.

• **Saturn spectacular**—The *Saturn* launch will be a ballistic shot to 90-mile altitude and 200 miles downrange. It will, for the most part, duplicate the successful first launch of the big 1.5-million-lb.-thrust booster on Jan. 27, 1962.

One new experiment is planned. The 100 tons of water used to ballast the dud upper stages of *Saturn* are scheduled to be deliberately exploded at an altitude of 65 miles. The experiment is expected to provide information on the scientific effect that great amount of water would have at a high altitude.

• **Fourth attempt**—The upcoming *Ranger* shot is the fourth of the nine-flight series for the lunar hard-landing spacecraft. Three previous shots were failures.

In *Rangers I and II*, the *Agena B* upper stage failed to push them to escape velocity for the approximately 65-hour trip to the moon.

Ranger III—the first attempt to impact on the moon—failed when an extended burning time in the *Atlas* first stage pushed it into the wrong trajectory. It subsequently missed the moon by some 2200 miles.

Some NASA officials contended that if the Johannesburg Deep Space Tracking Facility had had command capability over the spacecraft, it could have corrected the error in trajectory. NASA has taken steps to prevent a recurrence of the situation, and Johannesburg now has operational control capability over *Ranger IV*.

Ranger III also failed to perform the terminal maneuver which would have pointed its television cameras at the moon. NASA said circuitry modifications have been made in *Ranger IV* to solve that problem.

• **High photo hopes**—*Ranger IV's* most important job will be taking and transmitting back to Earth television photographs of the lunar surface. In addition, it will conduct three other experiments which will test and record moon quakes, gamma rays and moon's radar reflectivity.

The best photos of the moon taken from the Earth previously have only been able to distinguish objects above one half-mile in diameter. The *Ranger* cameras—under favorable conditions—will be able to provide pictures in which objects 12 ft. in diameter can be seen.

The TV cameras will begin operating 2500 miles above the lunar surface or 40 minutes before impact. Picture taking will stop at approximately 15 miles or 8.1 seconds from lunar impact. During this period the cameras will send back to Earth one picture every 13 seconds or a total of more than one hundred.

Each picture received at the Goldstone, Calif., tracking station will consist of 200 lines which are built up over a period of 10 seconds.

The 730-lb. gold and chrome-plated spacecraft is 5 ft. in diameter at the base of the hexagon, and 8.25 ft. high in its launch position—with the solar panels folded up in the manner of butterfly wings. In its cruise position, it is 17 ft. in width and 10.25 ft. in height.

• **Duties**—During its approximately 65-hour flight, it will be called on to perform complicated tasks and maneuvers including:

—Leave the Earth, achieve a parking orbit and reach escape velocity of 24,500 miles an hour.

—Perform a three-axis maneuver in space to lock onto the Sun and the Earth.

—Accept correction commands from the Earth, change its orientation in flight and fire a mid-course motor to put itself on collision course with the moon.

—Re-establish its lock on the Sun and the Earth.

—Perform a terminal maneuver when it gets to within 5000 miles of the moon.

—Take television pictures of the lunar surface as it approaches the moon.

—Make studies of the composition of the lunar surface and its radar reflection characteristics.

—Separate a retro rocket and capsule system from the spacecraft when it is approximately 70,000 ft. above lunar surface.

—Fire the retro rocket to slow the capsule system from 6000 miles an hour to zero velocity some 1100 ft. above the surface of the moon.

—Detach an instrumented capsule containing a seismometer from the retro rocket so that it rough-lands after a free fall from approximately 1100 ft., survives the landing, positions itself and then sends, for 30 days or more, information on moon quakes and meteoritic impact.

The *Ranger* program is being carried out by the Jet Propulsion Laboratory, operated for NASA by the California Institute of Technology. In the *Ranger IV* spacecraft, the Aeronutronic Division of Ford Motor Company, Newport Beach, Calif., provided the lunar capsule and radio altimeter subsystems. ⌘

Western Electric Stoutly Defends Overall Nike Profit

by James Trainor

WESTERN ELECTRIC officials have emphatically denied receiving excessive profits on work done by their *Nike* subcontractors. They charged that the McClellan committee's figures "erroneously focus on only a part of the total payment."

Maintaining that profits should only be considered as part of the total *Nike* effort, C. R. Smith, Western Electric Vice President for defense manufacturing activities, told the Senate Permanent Investigations Subcommittee "this is the traditional method of pricing government contracts and is authorized by law and expressly sanctioned by procurement regulations."

Applying the total-effort criterion to Western Electric's work on the 26 subcontracts under subcommittee consideration would, Smith declared, show that the company had an after-taxes profit of 3.5 cents per dollar of sales. In total contract dollars, he said, this amounts to a $112,500,000 profit on contract costs of $1,432,600,000.

The committee contends, however, that Western Electric—prime contractor for the *Nike* family of air defense weapons—earned a 31.3% profit on a total in-house cost of $359.3 million. These in-house costs, according to subcommittee investigator Robert E. Dunne, were based on the cost of components produced by Western Electric, the expense of managing subcontractors, engineering services, and other costs not directly attributable to subcontractors.

• **Hot debate**—This method of calculating profits was sharply attacked by Sen. Carl T. Curtis (R-Neb.) and Smith—and defended with equal zeal by the subcommittee chairman, Sen. John L. McClellan (D-Ark.).

Both Smith and Curtis contended that the committee's method of calculating profits only on work actually performed, in Smith's words, "has no standing that we can discover in economics or accountancy."

McClellan, while careful not to draw any conclusions from the hearings so far, vigorously defended the subcommittee procedure of calculating profits on in-house efforts as the "crux" of the inquiry into missile procurement.

"Nobody said it is beyond what they deserve," McClellan said. "We are just getting the facts."

Smith compared the company's 3.5-cent profit on the sales dollar for the 26 *Nike* subcontracts under consideration with the 4.5 cents on the firm's civilian business over the past 10 years, and with the average of 5.5 cents earned

(Continued on page 44)

Record Funding

House Approves $47.8 Billion for Defense

A RECORD peacetime defense appropriation bill of $47.8 billion was unanimously passed by the House last week.

Included in the Fiscal Year 1963 appropriation measure was $157 million for the acceleration of the Air Force's *Dyna-Soar* program—$42 million more than the Administration had requested—and $11.5 million for the Mark 46 torpedo, as well as the full $491 million for the controversial RS-70 program.

In approving the bill for $47,839,491,000 in DOD obligational authority, the House went along with the Appropriations Committee recommendation that $20 million of the requested $100 million for the Mobile Mid-Range Ballistic Missile be cut. In making the recommendation, the committee report noted that "the Air Force is no longer authorized to undertake the development of a MMRBM, but is only authorized to initiate a program leading to the development of such a missile."

The two-day debate on the money measure largely centered around a provision in the bill which limits the amount that the government would pay to universities on indirect costs of research projects. This limit—set at 15% by the committee—was strongly opposed by universities on the basis that it would result in their, in effect, subsi-

(Continued on page 44)

Budget Bureau Report on Use of Non-Profits Finally Ready

THE LONG-AWAITED and much-delayed Budget Bureau study of the uses of non-profit firms for technical and management services for government agencies was reportedly ready for release last week.

Although the exact recommendations were not available, the report is expected to recommend that the government—and particularly the Defense Department—conduct in-house more of the work presently contracted to universities and non-profit organizations.

The study is also expected to point out that one of the most serious results of the use of extra-government organizations has been a deterioration of in-house capabilities. In some cases, the Budget Bureau found, in-house organizations were second-rate and unable to control government research and development efforts.

Higher salaries paid by non-profit organizations—together with the prestige of the work they do—is expected to be blamed for the government's loss of technically qualified people.

The study—initiated by the Budget Bureau at the request of the President last July—was originally to have been completed by last Dec. 1. It reportedly covers 70 different contract arrangements, compiled from questionnaires to officials both in and out of government and data supplied by an interagency working group.

Conflicts-of-interest arising from government employment of non-profit agencies to manage government programs also received special attention.

The review covers universities and "other private institutions and business enterprises, both profit and non-profit, engaged in the operations and management of Government research and development programs," according to a Budget Bureau official.

It also covers "comparable in-house Government operations," he said.

• **Study goals**—According to the President's letter outlining the objectives of the study, the "product of the review should be recommendations to guide future executive action" in this area.

The specific points that President Kennedy outlined:

—The effect of the use of contractors on direct Federal operations.

—The policies to be followed by the government in controlling salaries and fringe benefits of nonprofit organization personnel.

—The criteria for determining whether a function should be performed by the government or outside of it.

—The policies to apply in selecting outside contractors.

—The means of reviewing and supervising contractor operations.

—The policies to be followed in determining fees and cost-reimbursable items.

Apollo Study May Have Vast Effects

NASA has initiated a systems engineering review of the *Apollo* mission which promises to have vast repercussions for the total U.S. lunar landing program.

One immediate effect has been a delay of at least three months in the selection of an associate contractor for the *Apollo* spacecraft's lunar-landing module. The delay could stretch to six months, a top NASA official told MISSILES AND ROCKETS.

It will also affect the command and service modules to varying degrees.

The study was ordered by D. Brainerd Holmes, Director of NASA's office of Manned Spaceflight. Its purpose is to define completely the first *Apollo* mission and its backup, which will have a time period two years longer.

It is necessary, Holmes said earlier, "because to commit our resources unwisely could cost us billions of dollars and thousands of lost man-hours."

The review is mainly concerned with the four possible methods of accomplishing the first manned lunar landing —earth-orbital rendezvous, lunar-orbit rendezvous, lunar-surface rendezvous, and direct flight with the *Nova* booster.

It is certain, NASA officials report, that some form of rendezvous mission will be chosen. Earlier, NASA has indicated that the Earth-orbital mission was leading.

When queried by M/R, Holmes refused to say what method he favors for the first mission. He did say, however, that combinations of the various missions "look good."

Holmes also indicated that there was a chance that something besides earth-orbital rendezvous would be chosen.

In the lunar-orbit mission, the *Apollo* spacecraft would go into orbit around the moon and a two-man capsule would be detached to land on the surface. For the return trip, the capsule would launch from the moon and rejoin the spacecraft in orbit.

The review is being conducted by the System's Engineering group in the office of Manned Space Flight, with the aid of groups from the Jet Propulsion Laboratory, Manned Spacecraft Center, and the Marshall Space Flight Center. The American Telephone & Telegraph Co., which has a systems engineering contract with NASA, will also work on it.

• **Mercury also eyed** — M/R has also learned that the space agency is currently involved in a review of Project *Mercury*.

NASA is considering extended orbital missions to fill the gaps between *Mercury's* three-orbit and 18-orbit flights.

Prime attention is being given to a seven-orbit flight which would extend the *Mercury* capsule life support system to its maximum.

If approved—and the chances are 50-50—the attempt would be made during the *MA-8* mission later this year, NASA officials said.

The extended mission is currently being reviewed by *Mercury* officials at the Manned Spacecraft Center and George M. Lowe, Director of Spacecraft in the Office of Manned Space flight. No recommendation has been made.

The principal drawback to approval is that it would require the deployment of vast recovery forces by the Navy.

During the *MA-6* flight on Feb. 20, 1962, some 20 ships, 15,000 personnel and hundreds of planes were required to cover the three possible impact areas.

Martin Plans Big Booster Construction Facility

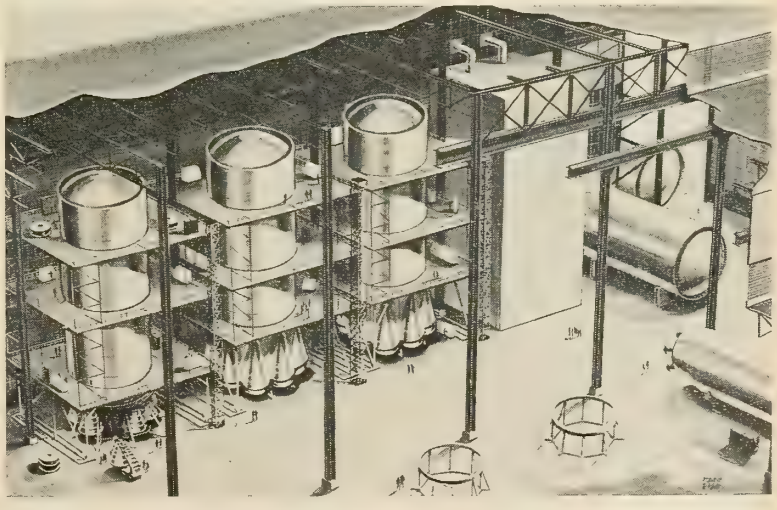
PLANS FOR the manufacture and shipment of giant *Nova*-type liquid boosters have been prepared by Martin Co.'s Space Systems Division for the firm's Middle River, Md., facility.

The same factors that once made the site ideal for seaplane building and testing qualify it for large booster production, say Martin spokesmen. Ocean-going barges could tie up at company docks at Middle River, and the boosters could be moved down a ramp directly from the assembly and test building.

Plans call for the use of many existing facilities and the construction of relatively few structures. One test building would be constructed close enough to the water to permit use of barges carrying liquid nitrogen.

Barges for *Nova* boosters would be 300 ft. long, 75 ft. wide, and have a 20-ft. deck height. Since the booster would be lighter than usual barge loads, ballast would have to be added. *RIFT*-type stages could also be handled.

Existing facilities can handle boosters 30 to 50 ft. in diameter and more than 100 ft. tall. The architectural engineering firm of J. E. Greiner Co. assisted in the booster facility plans and the shipbuilding division of Bethlehem Steel Co. aided in the water transportation phases.



MARTIN'S proposed assembly/checkout building would provide maximum accessibility.

In new setting . . .

NASA Institute Draws Top Scientists

Outstanding professors and students recruited in U.S. and abroad help to solve theoretical problems

by Michael Getler

NEW YORK—NASA's decision to move its Institute for Space Studies here from the Goddard Space Flight Center in Greenbelt, Md., is paying off handsomely in scientific talent.

The scientists who are active either full-time or on a part-time basis in the Institute's programs comprise one of the top collections of talent in the country.

Successful debut of the space studies group in its new location adjacent to Columbia University is in large measure due to its director, Dr. Robert Jastrow, an enthusiastic and articulate spokesman for the business of outer space who at 36 is already prominent in the scientific community.

Dr. Jastrow describes the prime mission of the Institute as one of direct contribution to the broad theoretical aspects of the U.S. space program. An important secondary role has been the recruiting of scientific manpower not previously exposed to the wide range of NASA space study.

Since its establishment here last May, the Institute has reached into the staffs and graduate student bodies of Columbia, New York University, City College of New York, Brooklyn Polytechnic Institute, Yale, and Princeton in an attempt to bring this talent to bear directly upon many of the space agency's programs.

Conversely, many of the Institute's staff have accepted teaching and lecturing appointments at these same universities.

The Institute has undertaken a continuing round of seminars covering planetary fluid dynamics, turbulence and convective transport, relativity and gravitation, advanced astrophysics, and solar system origins. Coming to New York to lead these programs are such men as Dr. Harold Urey, Nobel laureate from the University of California; Dr. Jule Charney, meteorological expert from Massachusetts Institute of Technology; and Dr. Robert Dicke, Princeton's leading thinker on the aspects of relativity and gravitational phenomena.

NASA'S Dr. Robert Jastrow . . . "no special in" on lunar program, but special interest.

Other scientists who have agreed to participate in academic programs include Dr. Joseph Chamberlin of the Yerkes Observatory in Wisconsin, who lectured here this month on planetary atmospheres, Dr. Vernon W. Hughes, associate chairman of Yale University's Physics Department; and Dr. Maurice Ewing, director of Columbia's Lamont Geological Observatory.

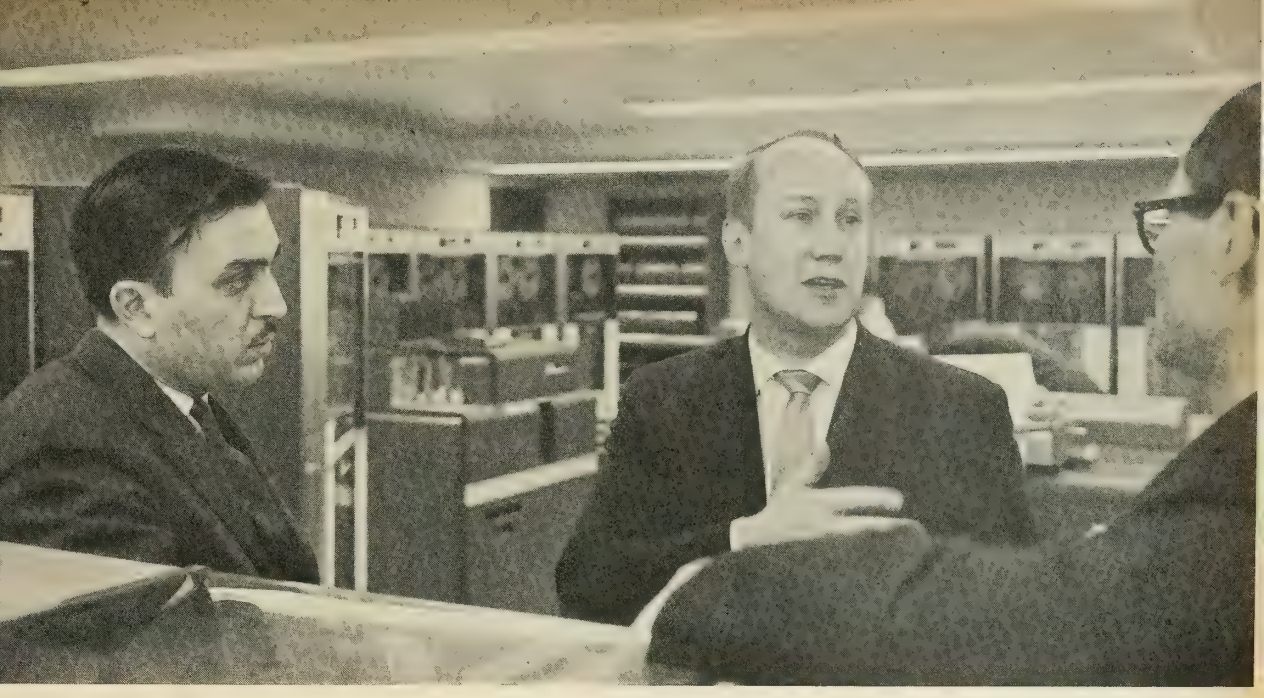
Though the Institute for Space Studies is heavily engaged in such educational projects, its basic work remains pure research. Its broad range of theoretical studies eventually help to shape the satellite and deep space probe experiments of NASA.

• **Senior staff**—At the core of the group is a 20-man senior scientific staff composed of four permanent members of the Institute and 16 scientists, representing several countries, assigned annual fellowships to work here by the National Academy of Sciences. All members of the senior staff are holders of doctorate degrees.

The four man full-time staff headed by Dr. Jastrow also includes Dr. A. G. W. Cameron, on leave from the Atomic Energy Commission of Canada, nuclear physicist Dr. Jackson Herring, and astrophysicist Dr. Albert Arking.

Broadly speaking, the Institute's major effort at this time is applied to studies of the upper and lower atmospheres and investigations of the evolution of stellar and solar system formations.

• **Upper atmosphere**—The studies of the upper atmosphere are basically concerned with the density, composition, and structure of this broad band of our atmosphere which stretches to the limits of the Van Allen belt, some 54,000 miles from Earth, where it meets



PROF. WOLFGANG PRIESTER discusses his calculations on upper atmosphere heating with Drs. Rasool and Jastrow, in the computing room of the Institute. Dr. Priester is a Senior Research Associate, on leave from the Bonn Observatory, where he is deputy director. Dr. Rasool, also a Senior Research Associate, received university training at India's Lucknow University, Pakistan's Geophysical Institute, and the University of Paris. He is on leave from the Laboratoire de Physique de l'Atmosphere in Paris.

the fringe of the interplanetary medium.

The research is focused on the degree of solar control over this vast expanse, the manner of solar deposition of energy, properties of the magnetosphere (the charged layer of particles discovered by Van Allen) and the interaction of these particles with the surrounding atmosphere.

A considerable contribution to the correlation between periods of intense solar activity and changes in very fundamental atmospheric behavior has been made by Dr. Wolfgang Priester, on leave from Bonn University Observatory in West Germany.

Jastrow says the efforts of Dr. Priester have developed an accurate idea of the relationship between the general level of solar activity and upper atmosphere temperatures and densities.

On the basis of previous solar observations, including periods of severe solar activity, his work has provided a platform for predicting variations in radiation levels and atmospheric temperatures for the next years of sunspot minimums.

Many of Dr. Priester's studies have been fortified by the work of Dr. Luigi Jacchia of the Smithsonian Astrophysical Observatory, whose analysis of satellite drag fluctuations on *Sputniks II* and *III* and *Vanguard I* could be correlated with Priester's measurements of variations in solar activity during the same period. The agreement of these studies provides considerable basis for ruling out apparent random fluctuations in satellite drag in favor of definitive atmospheric causes.

• **Lower atmosphere**—The lower-atmosphere investigations are currently centered on a detailed investigation of the IR radiation data collected by NASA's *Tiros* satellites. Dr. Jastrow points out that while the cloud cover photographs that *Tiros* turns out are of great value for the immediate objectives of weather forecasting, the IR packages aboard these vehicles are also apt to have a strong impact on long-range forecasting and perhaps eventual weather control.

The essence of the weather problem, Jastrow asserts, is the uneven heating of the earth's lower atmosphere by global variations in the re-radiated IR solar energies. This unevenness creates changes in temperatures and pressures which give rise to often unpredictable weather patterns.

Though the study of the IR data collected by the broad-band detectors carried aboard *Tiros* is only the first step, the continuance of this type of pattern analysis with advanced meteorological vehicles such as *Nimbus* may eventually provide an accurate map of variations in the earth's IR radiation patterns, lower-atmosphere temperature distributions—and a significant clue to the overall energy transfer process between the sun, Earth, and the intervening atmospheres.

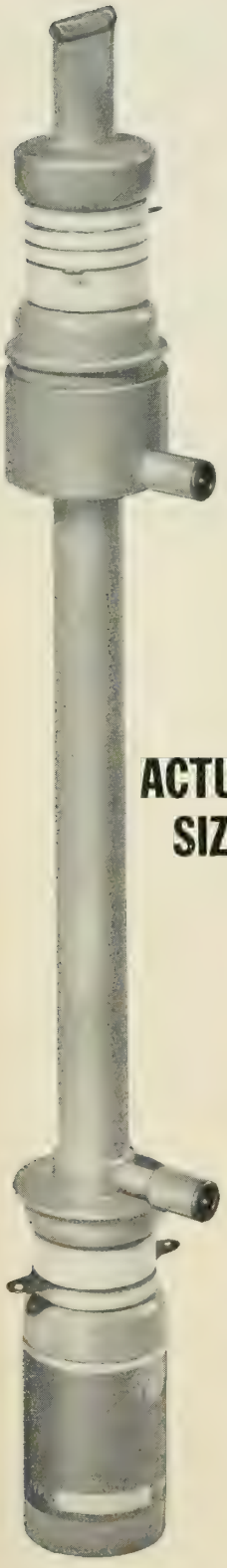
The Institute's analysis of *Tiros* data is being handled by Dr. Ishtiaq Rasool, a Pakistani on leave from the University of Paris. Assisting Dr. Rasool, along with Dr. Jastrow is Mr. Cuddapah Prabhakara, of India.

• **Stellar and solar origins**—The third major area of current interest at the Institute is divided between investigations of stellar evolution and solar system origins.

On hand at the Institute to help unravel the stellar story are Dr. Cameron—a leading authority on the early stages of stellar formation from the condensate of interstellar gas and dust—and Dr. Hong-yee Chiu, on leave from his post as professor of Physics at Yale, an expert in the study of the supernovae, the cataclysmic explosion which eventually destroys the star.

Though considerable knowledge of stellar formation has been gathered through current radio astronomy techniques and early rocket and satellite probes, Dr. Jastrow points out that a vast amount of new data on the subject will be made available with the advent of the series of *Orbiting Astronomical Observatories* (M/R, Dec. 4, p. 16) the first of which NASA will attempt to place in orbit late next year.

The scopes mounted in the *OAO's* are expected to give scientists their first unimpaired view of the ultraviolet stellar emissions which are mostly filtered out by the Earth's atmosphere. ❖



ACTUAL SIZE

Now . . . SPERRY packs 10 W output, 60 db gain into a 10 cu. in. TWT

Because of the space age demand for smaller, more rugged components with outstanding performance characteristics, the new STX-186 is now available on 60-day delivery from Sperry Electronic Tube Division.

This new X band traveling wave tube is ideally suited to the rigors of aerospace application. It delivers a minimum 10 watts of CW output across X band, at gain levels up to 60 db. Yet it is only 10½ inches long, weighs only 12 ounces, and occupies only 10 cubic inches of payload space. Rugged metal-ceramic construction enables the PPM focused STX-186 to withstand the shock, vibration, and altitude extremes of the most demanding aerospace environments.

Designers can realize maximum benefit from the tube's small size by adapting mounting and cooling arrangements to meet specific environmental demands. Cooling may be air, heat sink, or liquid.

BROAD APPLICATION POSSIBILITIES

In addition to its small size and physical ruggedness, the STX-186 boasts performance characteristics that open a broad range of application possibilities.

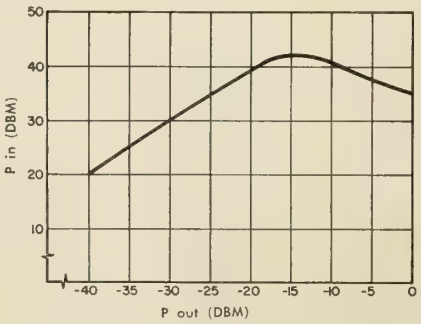
Across the entire band of 7 to 11 Gc, this new TWT delivers a minimum 10 watts CW at up to 60 db gain. The dynamic range of broadband signal amplification extends 25 db below saturation. These characteristics make the STX-186 eminently suitable for rocket, drone, and aircraft application in radar augmenter, ECM, or comunications systems.

IMMEDIATE AVAILABILITY

Sperry is now producing the STX-186 in quantity, and limited numbers are available within 60 days of receipt of order.

A NEW TECHNICAL BROCHURE, WHICH DESCRIBES THE CHARACTERISTICS OF THE STX-186 IN DETAIL, IS NOW AVAILABLE. FOR YOUR FREE COPY, WRITE TO SPERRY ELECTRONIC TUBE DIVISION, SEC. 123 , GAINESVILLE, FLORIDA.

To avail yourself of the outstanding performance of this new tube, place your order now. Your Cain & Co. salesman, who represents Sperry Electronic Tube Division, will be happy to provide application assistance and quotation. Or you may communicate directly with us at Great Neck, N. Y.



Typical drive curve STX-186 at 9 Gc

SPERRY ELECTRONIC TUBE DIVISION

GAINESVILLE, FLA. / GREAT NECK, N. Y.
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Technical Countdown

ELECTRONICS

Energy Converter Selected for SNAP-10

Radio Corporation of America last week was selected by North American Aviation, Inc., to develop and produce thermoelectric modules for the first orbital nuclear reactor, *SNAP-10A*. NAA's Atomics International Division is developing the 500-watt nuclear APU under a joint Atomic Energy Commission/Air Force program. First *SNAP-10's* are scheduled for flight-testing in late 1963. Under the six-month, $2-million contract, RCA's Electron Tube Division will employ a new thermoelectric alloy. Composition of the lightweight metal has not been revealed by developers; however, it is reported to have high melting point, superior mechanical strength, and good energy-conversion efficiency.

New Epitaxial-Growth Furnace Built

Precise control over complex epitaxial growth processes can now be maintained even by semi-skilled operators, says Motorola. A fully automatic furnace for the gas-phase crystal growth of mesa and silicon-planar transistors is in use at the company's Semiconductor Products Division in Phoenix, Ariz. The production-line equipment is also designed, its developers report, for ultimate use in building complex integrated circuit patterns. Up to four layers of alternating N- and P-type semiconductor materials can be grown, and additional layers can be produced by recycling after each four-layer growth operation is completed.

Mercury Net to be Updated

Advanced wide-band PCM telemetry receivers and other electronic equipment to update the existing *Mercury* tracking stations will be provided by Vitro Electronics. In announcing the award, NASA indicated that the new systems will be required to support future *Mercury, Gemini,* and *Apollo* manned orbital experiments. Systems supplied under the over-$100,000 contract already are being installed, and the program reportedly will be completed within the next two months.

AMR Downrange Stations Get Assist

A Sperry-Rand Corp. Univac 1206 is the heart of a new real-time data handling system expected to improve radar tracking at the Atlantic Missile Range. Now in operation between Cape Canaveral and Ascension Island, the computer will assist downrange trackers in locking onto missiles and space vehicles. It also will provide continuous inputs to antennas during re-entry radar blackout phases of ICBM flights. Stored trajectory and tracking data will be fed to the Ascension computer by radio and teleprinter links from Canaveral.

ADVANCED MATERIALS

Pure Molybdenum Superconducts

Ultra-pure samples of molybdenum exhibit superconductive properties at 1°C above absolute zero, Bell Telephone Laboratories scientists report in the current issue of *Physical Review Letters*. The key to the phenomenon is purity—even trace impurities of the order of a few parts per million interfere with superconductivity. Bell experts used samples of the metal prepared both by zone refining and long-time arc furnace heating. The extremely low transition temperature precludes direct use of moly for superconducting magnets. But the discovery is expected to result in significant developments, since other ultra-pure metallic elements may exhibit similar characteristics.

Radar Crumbles Rock and Concrete in UK

A process for breaking rock and concrete by high-frequency radar waves has been developed in England by Mullard Ltd. and the Building Research Station of the Department of Scientific and Industrial Research. The waves produce an intense wedge of heat which splits the material. No noise is produced: Switching on the power results in a slight click and the appearance of thread-like cracks. For mining, constructing silos, or in other large operations, holes are bored, waveguides inserted and the radio energy applied.

Laser Beam Cuts Diamonds

General Electric engineers have been punching holes in diamonds with a laser beam of narrow, coherent light. The holes were cut in 200 millionths of a second, generating temperatures in the 100,000°F range. The diamonds were not structurally damaged. While diamonds have been cut with electron beam equipment, GE experts say the laser method has a number of advantages—including lower cost and higher operating speeds. The beam also has been used to cut stainless steel and tungsten, among other materials.

Helmet Visor Fogging Eliminated

Chemists at the Armour Research Foundation have found that pilot-visor fogging can be counteracted by inducing an even dispersion of water vapor over the entire surface. This prevents moisture exhaled by an astronaut in a pressure suit from collecting in tiny droplets on his viewing visor. The fogging condition occurs whenever the outside temperature drops below that of the pilot's exhaled breath. The thin coating applied by Armour produces no distortion, haze, or other discernible optical interference.

PROPULSION

Large Solid Components Contracted

A design and demonstration contract for large nozzles capable of withstanding extended firing durations, hypergolic ignition for solids and advanced thrust vector control systems has been awarded to United Technology Corp. All systems will be checked out in a large number of subscale firings before final design. The $2.1-million Air Force contract also includes demonstration firings on two full-scale segmented, booster-sized rockets—one generating some 250,000 lbs. thrust and the other about 500,000 lbs. thrust.

ASW ENGINEERING

Undersea Nuclear Explosions Simulated

Navy scientists are detonating explosive charges of 0.2 grams in a water tank under centrifugal forces high enough to produce g-pulls 300 times that of the Earth. The test program, at White Oak Naval Ordnance Laboratory, will supply data on the characteristics of nuclear explosions in deep water. Photographic records will be analyzed to study the formation of water columns produced by shallow water explosions of nuclear proportions, the diffusion of nuclear debris and other explosion criteria.

G Forces May Help Against Radiation

Aerospace Medical meeting also hears reports on Navy moon magnetic experiment

by Heather M. David

ATLANTIC CITY, N.J. — Increased g forces may in some undetermined manner protect against the effects of radiation.

Research at the Air Force School of Aerospace Medicine has disclosed that rather than having a detrimental effect, the combination of g forces and irradiation actually increased animal radiation tolerance.

In a paper presented at the Aerospace Medical Association meeting here, four SAM scientists said that they had exposed groups of rats to graded doses of C_o^{60} gamma irradiation before and at various time intervals following centrifuge runs. Although the trend of protection may not be great, they felt, it could be extended by using longer periods of latency between the g dose and exposure to irradiation.

They also concluded that after exposure to irradiation, resistance to greater g forces may be possible after a latent period of longer duration than they had used in experimentation.

• **Magnetic field studies**—A highlight of the program was the revelation that two Navy volunteers have completed the first experiment during which the magnetic field of the moon was simulated for a two-week period.

The subjects were confined to an eight-ft.-square area within the Naval Ordance Laboratory's field coil system at White Oak, Md., near Washington, D.C. By creating a compensating magnetic field, the coil system creates the same magnetic environment as the moon —about 1/1000 as strong as that of Earth.

Project director Dietrich E. Beischer, PhD, of the Navy School of Aviation Medicine, told the Aerospace Medical Association that "at this time I can say that no acute physiological reactions were observed during the tests. However, evaluation of the results is still in progress and I can only give the full story at a later time."

Dr. Beischer said earlier that "an educated guess suggests effects on biological rhythms and possibly space and time perceptions."

To create ideal conditions, all ferromagnetic objects were excluded from the personal belongings and equipment used in the experiment. All furniture and personal equipment was constructed of non-ferromagnetic materials.

The volunteers took a number of visual and psychological tests.

Under the project, which is supported by NASA funds, Dr. Beischer also is conducting research on extremely high magnetic fields and their effect on animals.

The NOL field coil system consists of 12 independent circuits made from special 141-conductor magnetic field cable contained in a coil framework. This framework is oriented along the lines of magentic north and south, so that the magnetic field at the east-west heading is valued at zero. The two active components of the system compensate for the horizontal factor of the Earth's magnetic field, and the vertical factor of the Earth's magnetic field.

The building housing the coil is as free from metal as possible—its construction being screend of iron and steel. Nails in the building are copper, light switches are porcelain, drains are transite, and beams are wood. Even the sand which went into the mortar was screened to make certain it contained no minute particles of iron oxide.

NOL's system is the largest one in the country capable of producing uniform fields of low intensity in three mutually perpendicular directions—and the only one large enough to permit human habitation within the framework of its coils.

• **Limit of impact tolerances** — A Vought Astronautics engineer presented a new concept in determining how much impact acceleration a human can stand. He noted that although mathematical techniques and specialized electronic analog computers have been developed which can predict man's mechanical response to impact acceleration, there is no method to predict an individual's physiological tolerance limit.

The engineer, A. B. Thompson, suggested that limits should be set by the force exerted per unit area on the body by the restraint or support system at maximum deceleration.

Thompson said studies of blast, sled and automobile accident survivals indicated that 28 to 32 lbs. psi is the onset level for shock and 45 to 55 lbs. psi is the level for 50% mortality for transverse accelerations of less than .07

Panel Reported Finding DOD Has Biomed Know-How

THE SPECIAL bioastronautics panel set up by the National Aeronautics and Space Council has found that the existing capability for biomedical research lies within the Department of Defense, a member of the House Committee on Science and Astronautics has revealed.

Rep. Emilio Q. Daddario (D-Conn.), long a student of the problems of the nation's life sciences program, told the Space Medicine Branch of the Aerospace Medical Association that it was his understanding that the panel had made this finding, although the report remains classified.

Daddario added that "the only point to be resolved is how this can best be applied to the nation's space program, both civilian and military."

During his service on the House Space Committee, the Connecticut Democrat has frequently warned against waste of resources through duplication of biomedical research facilities.

On another subject, the congressman told the Branch, gathered at Atlantic City for the 33rd annual meeting of the AMA, that caution should be exercised in following President Kennedy's suggestion that the field of space medicine be designated as one in which the U.S. might cooperate with the USSR.

He pointed out that although the Russians are in a position to have more advanced knowledge than we have, "we cannot afford an open-handed approach that would place other considerations above the national security."

second duration.

• **Weightlessness**—In another paper from Vought Astronautics, Dr. Charles F. Gell emphasized the necessity for studies at the cell level of the effects of weightlessness on man. He said that just as two-phase systems—like air-in-water and air-in-oil—react differently in a weightless state, so might the constituents of cells.

Dr. Gell also noted that reports on Russian aerospace medical research indicated that cells exposed to prolonged weightlessness had an increased rate of mitosis. The levels of radiation reported during these Russian studies were not high enough to have been responsible for producing this response.

Dr. Gell also announced that Vought Astronautics has designed a satellite system to record and transmit the visual microscopic changes in all samples exposed to zero-g.

Another problem of weightlessness was discussed by Lt. Commander Norris K. Combs, of the U.S. Naval Air Station at Norfolk, Va.

Combs suggested that the absence of the weight of food might impair the usual method of exposing food to gastric juices, thus stopping digestion. He added that in early spaceflights it might be necessary to provide personnel with drugs to stimulate peristalsis.

• **High gravity**—Plants and lower animals subjected to chronic centrifugation have shown significant alterations in life span and development.

Several members of the department of physiology of the State University of Iowa concluded that while terrestrial forms of life could probably survive on other planets with different gravitational stresses, they would suffer developmental alterations of one sort or another. The group has studied a number of different life forms, including mice and fly larvae.

• **Radiation**—Exposure to neutrons during space travel may have a profound effect on man's ability to withstand other stresses.

Researchers at General Dynamics' Life Sciences Laboratory and the U.S. Naval Radiological Defense Laboratory found that neutron exposure affected the cold tolerances of rats much more than did X-ray exposure. The researchers cautioned that before an "acceptable dose" of radiation is set for the crew of a space vehicle, more information should be accumulated on its effect on other stress tolerances.

A space radiation monitoring system developed for the Air Force by the Philco Corp.'s Western Development Laboratories was described at the conference. This system will be used on future satellite flights, and is capable of:

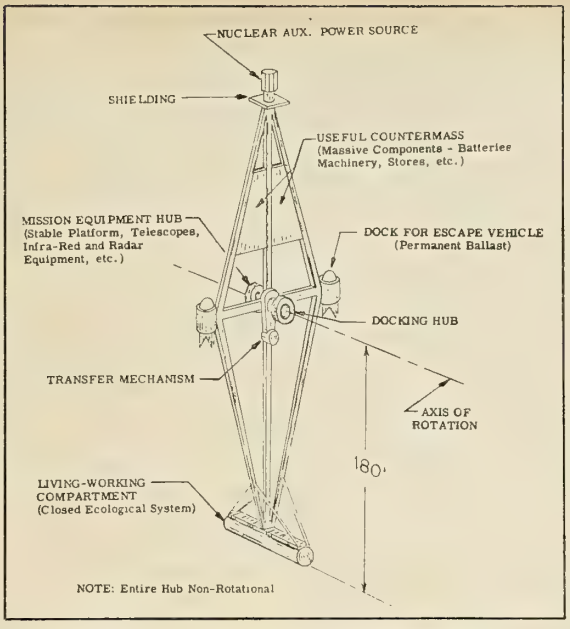
1) Differentiating between radiations of different types and determining the intensity of each type.

2) Measuring the dose rate associated with each particle type in each energy interval, the overall dose rate from all particle types and energies, and the time-integrated dose.

3) Telemetering the information to ground receiving stations.

4) Enabling display of overall dose rate and time-integrated dose information to the vehicle passenger.

The system is designed for a six-month life expectancy, and was developed under an Air Force contract for the Holloman AFB Aeromedical Research Lab.



AF-PROPOSED "dumbell" vehicle would simulate gravity.

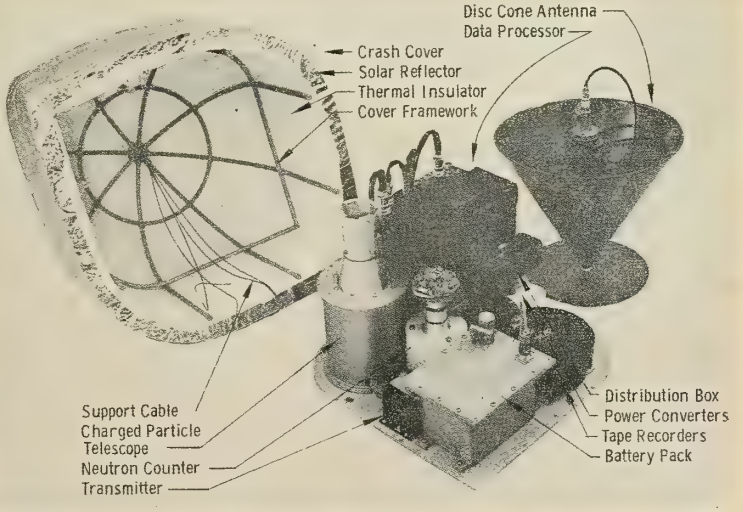
• **Danger of lasers** — Lasers which produce extremely intense, monochromatic beams may be hazardous to the eyes of ground and space crews.

Dr. Milton M. Zaret, of the New York University Medical Center department of ophthalmology, reported that experiments on pigmented rabbit eyes demonstrated that profound retinal damage was produced by a pulsed, ruby optical maser emitting a 0.1 joule in a beam having a diameter of 1 centimeter in a single 0.5 millisecond burst.

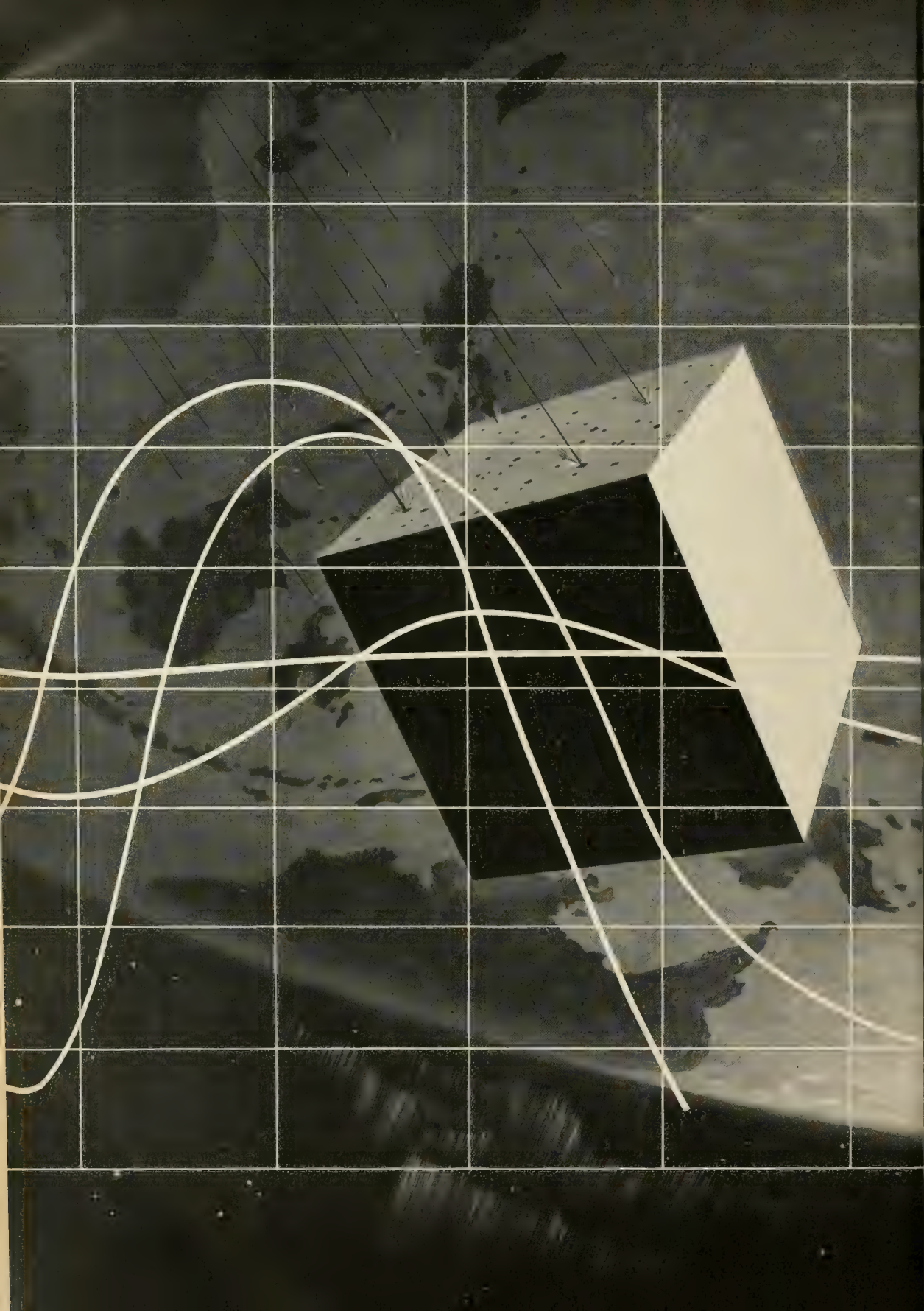
He said that exposure of 0.5 milliseconds to this beam formed a lesion resembling one produced by the fireball of nuclear exposures.

• **Vibration and altitude**—Animals vibrated in an altitude of 18,000 ft. are much more subject to pulmonary damage than those vibrated at sea level, a group of researchers from The Boeing Co. reported.

They noted that there was no significant mortality increase up to 10,000 ft. simulated altitude, but above that mortality increased with altitude. ⁂



PHILCO CORP. described at AMA meeting this space radiation monitoring system, to be used on future satellite flights.



A MATERIALS LABORATORY IN SPACE

A comprehensive understanding of the reaction of materials to outer space is an important key to this country's space program. In their study of materials, scientists at Lockheed Missiles & Space Company found the problem could be most graphically depicted by showing the various environmental factors impinging on a simple cube-shaped vehicle. A cube, placed in a noon polar circular orbit, would allow unusual isolation of the effects of space on materials; make their measurement simpler and more accurate; and offer a built-in control of the results. For example: The horizontal surface facing away from the earth would receive only direct solar insolation, while that facing the earth would get mostly earth shine and earth-reflected solar radiation. This hypothetical model lucidly illustrates the effects of such phenomena as: Solar irradiation, sputtering, micro-meteoritic erosion, solar corpuscular radiation, auroral radiation and the like.

Guided by engineers and scientists of outstanding calibre, Lockheed Missiles & Space Company has won its place in the forefront of many disciplines in missile and space technology. And such progress constantly creates key positions for others of proven ability. Lockheed's location in Sunnyvale and Palo Alto on the beautiful San Francisco Peninsula is ideal. So is the climate—physical and mental.

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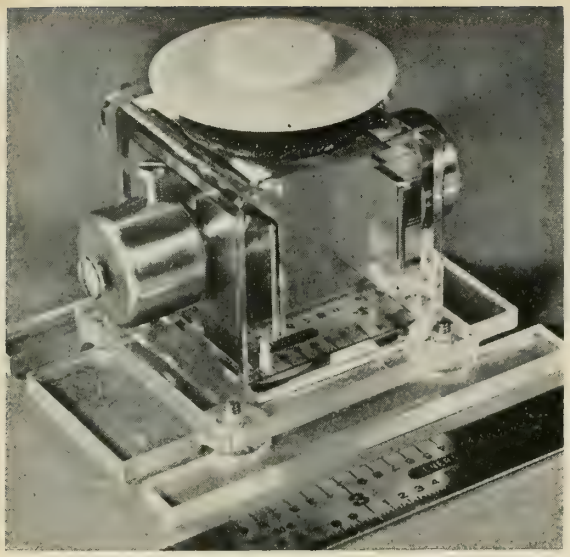

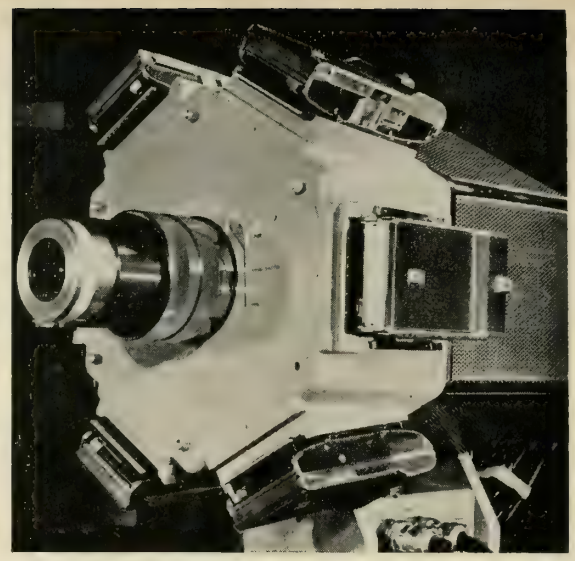

LEFT: *Standard nitrobenzene-filled Kerr cell of type used in KFC-600.* **RIGHT:** *The camera uses six of the cells.*

optics

Kerr Cell Camera Has Record Speed

by Arthur H. Collins

PASADENA, CALIF.—An ultra-high-speed Kerr cell framing camera—capable of taking six frames at a rate of 100,000,000 frames per second with exposure times as brief as five nanoseconds—has been developed by Electro-Optical Instruments, Inc.

The camera, designated KFC-600, has wide applications in aerospace studies of physical phenomena such as arc and plasma gas discharge, explosive detonation, hyper-velocity impact, shock wave studies and nuclear instrumentation.

EOI says the new tool surpasses previously available devices in framing speed and number of frames available. The best earlier instrumentation cameras could take only three frames at rates of less than 15,000,000 per sec.

The KFC-600 makes possible studies of an entire history of a physical phenomenon such as an explosive detonation. Previous studies were limited to a few frames of sequential exposures of the same type of phenomenon during the repetitious experiments.

The KFC-600 instrument system consists of a camera unit and a remote-control electronics chassis. The camera unit is made up of a single lens, a six-sided prism, six Kerr cell shutters and six film holders which permit use of Polaroid film. The remote control chassis houses all electronics necessary for timing and pulsing.

• **New use of old theory**—Operation of the system is based on a theory developed by John Kerr almost a century ago. This theory lead to the development of a light valve, commonly referred to as the Kerr cell, which is finding much use today in the measurement of very small time intervals.

The heart of any photographic system is the shutter. The KFC-600 is no exception, but instead of a single shutter this system uses six, each controlled by an electronic impulse.

The Kerr cell shutter consists of two flat plates or electrodes immersed in a fluid (nitrobenzene) which becomes birefringent when an electric field is applied. When oriented between two polarizers crossed for minimum light transmission, the cell constitutes an electro-optical shutter.

The crossed polarizers prohibit passage of light when no voltage is applied. When a high voltage is applied at the electrodes, the state of polarization is altered and light is passed through the second polarizer onto the film.

An isotropic substance (one having the same properties in all directions) which exhibits the property of optical birefringence when subjected to an electrostatic field is said to exhibit the electro-optical Kerr effect. Nitrobenzene is such a substance.

To better illustrate the influence of an electric field upon a liquid which exhibits the Kerr effect, consider the arrangement of lenses L_1 and L_2, polarizers P and A, and the Kerr cell in Fig. 1c, where S is the light source and I is its optical image.

A beam of light enters the cell plane polarized at an angle ψ with respect to the applied electric field. The electric vector in the incident light may be resolved into two components, one parallel and one perpendicular to the applied field.

These components possess different wavelengths, since they traverse the cell fluid with different velocities as shown in Fig. 1a (exaggerated).

In other words, there will be a continuously increasing difference in time phase between the two components of light as they traverse the cell. Since the state of polarization of the light at any point is dependent on the difference in time phase between the two components, the resultant light emerging from the cell will no longer be plane-polarized.

If the angle ψ of the plane of polarization upon entering is 45 degrees and the angular time phase difference δ, between the components is an odd multiple of $\pi/2$, the light will become circularly polarized. If δ is an odd multiple of π, the emergent light will be plane polarized at 90 degrees to the

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plane of polarization of the entering light; for δ equal to an even multiple of π, the light leaves polarized just as it entered. For any other values of δ, the light will be elliptically polarized. Fig. 1b illustrates the states of polarization for $\delta=0$, $\pi/4$, $\pi/2$, $3\pi/4$ and π. When δ equals π the shutter is in full-open operation.

For optimum operation as an electro-optical shutter, the angle between the plane of polarization of the entering light and the applied electric field (ψ) must equal 45 degrees and the angle at which the analyzer is set relative to the applied electric field (α) must equal -45 degrees.

As the potential applied to the electrodes is increased, the amount of light passed by the shutter increases until the light becomes polarized in the plane of transmission of the analyzer, A (Fig. 1c). At this voltage point the shutter is fully open and any further increase in potential causes a decrease in the light transmitted.

The condition of full-open shutter operation is when $\pi lKE_o = \pi/2$ where l=length of Kerr cell electrode, K= Kerr constant of liquid used. Taking $E_o=V_o/d$ where d is the separation of the plates, this leads to

$$V_o = 300\,(21K)^{-1/2} \text{ volts}$$

Since the Kerr constant (K) is at best of the order of 10^{-5}, shutters of wide operture require very high voltages. An alternative would seem to be to increase the lengths of the electrode plates (1). However, any increase here adversely affects the angular field and limits the operating speed of the shutter by increasing the electrostatic capacitance of the cell.

• **Characteristics of cell**—The general characteristics of the Kerr cell are:

(1) Areal aperature: 2 by 4 cm at smaller end and 3 by 4 at larger end.

(2) Angular aperature: The apparent (refracted) dihedral angle between electrodes is 20 degrees and the apparent optical length between apertures is 3 cm.

(3) Operating voltage: At optical wavelength of 0.5μ the voltage required for full-open condition is approximately 35 kv and the Kerr cell capacity is approximately 25μμ.

To convert the Kerr cell to a useful photographic instrument, it is necessary to supply voltage pulses of suitable magnitude and duration at accurately predetermined instants. This requires development of switching techniques providing voltage pulses in the 25 to 50 kv range with transition times on the order of 10^{-9} seconds.

Fabrication of a hermetically sealed Kerr cell of wide aperature is a relatively simple problem; however, to provide a circuit to operate such a device is quite another matter.

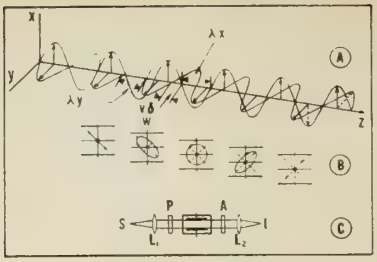

FIG. 1—*Light valve operating principle.*

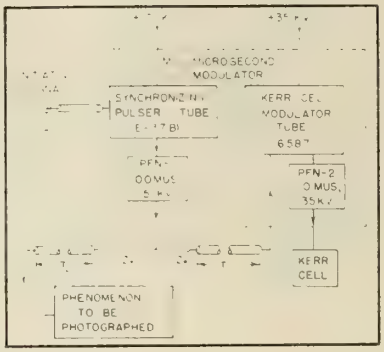

FIG. 2—*Diagram of Kerr cell shutter modulator and synchronizing system.*

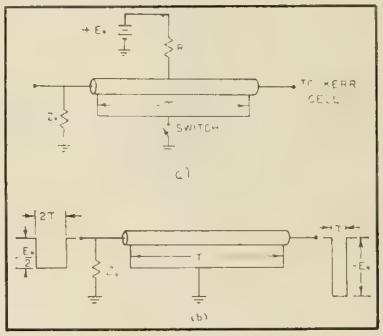

FIG. 3—*Operation of pulse forming network. (a) Prior to closing switch. (b) Voltage-time sequences after switch is closed.*

The principal requirements for the electrical circuitry can be stated as follows:

(1) It must provide a pulse of very high voltage (25-50 kv) and of very brief duration (10^{-8} second or less) and must be capable of accurate synchronization with the phenomenon being studied (of the order of 10^{-9} seconds or less).

A complete Kerr cell camera system block diagram is shown in Fig. 2. Parallel synchronization is used, rather than the tandom mode, because it permits synchronization over the entire duration of the phenomenon. An initiating trigger, externally supplied, simultaneously initiates the phenomenon under study and the shutter action of the Kerr cell by means of a synchronizing pulse generator.

As noted, the voltage pulse must be very brief and of high voltage. The duration requirement has been met by the design of a low-inductance circuit configuration and by operating a hydrogen thyratron at increased gas pressure.

The requirement for high voltage has been met in part by operating the thyratron at anode voltages greatly in excess of normal ratings, and in part by use of a newly designed pulse-forming network (PFN) which supplies a voltage pulse of amplitude equal to the full anode voltage. Fig. 3 shows the network to be a variation of the usual transmission line type of PFN widely used in radar modulators.

The PFN elements include a transmission line of electrical length γ, charged from a voltage source E_o, through a charging resistor R, and a switch which initiates the pulse formation by closing the switch, a voltage pulse of magnitude E_o and duration γ appears across the open or unterminated end of the line, while a voltage pulse of magnitude $E_o/2$ and duration of 2γ appears at the end of the line terminated in the characteristic line enpedance.

The PFN and terminating resistors are potted in a thermal setting, high-breakdown-strength plastic, in order to keep lead inductance to a minimum, and to decrease possibility of arc-over at elevated voltages.

Control electronics are housed in a standard relay rack with a 10-ft. cable to the recording instruments. All control functions are made at the control cabinet. These include high-voltage adjustments, interframe time adjustments, capping shutter control and main system power.

In addition to these standard controls, it is possible to monitor exact initiation of the shuttering action of each frame by means of low-voltage samples of the Kerr cell shuttering pulses. The timing pulses can be fed to an oscilloscope from a single connector on the front of the control chassis.

The design of the optical system of the KFC-600 offers several immediate advantages. After initial alignments have been completed, subsequent focusing and image adjustments are made on only two components, the lens and the prism. Another advantage is that both exposure and interface time can be arbitrarily selected to accommodate the amount of light available and the rate of growth of any time during the event because of the independence of exposure and interframe times.

Accessory option lenses are available that enable the system to cover magnifications ranging from 1:4 through 4:1 or objects as far away from the camera at 4 feet or down to a microscopic size. ■

A BLAW-KNOX "FIRST" ON PROJECT NIMBUS

NEW "X-Y" MOUNT PREVENTS GIMBAL LOCK

A new project, operated by the Goddard Space Flight Center of the National Aeronautics and Space Administration, is getting underway at College, Alaska. An 85-ft. Blaw-Knox Antenna will be used for advanced meteorological satellite projects.

Blaw-Knox has designed and built many 85-ft. antennas before, but this application called for even greater tracking precision so a new "X-Y" mount was designed that *eliminates gimbal lock at zenith.* The antenna is capable of moving through zenith position to all parts of the horizon. This is the *first* such mount to be put in service. This was a Blaw-Knox concept—a Blaw-Knox design—and Blaw-Knox precision construction.

It is 110 feet high, and has a 6000 sq. ft. parabolic aluminum reflecting surface. The substructure is of nickel alloy steel to withstand extremely low temperatures.

Blaw-Knox designs and builds to close tolerances, with minimum deflections, at reasonable cost—fabricates in steel, special alloys and aluminum—designs to your needs, or builds to your specifications. Complete research, engineering, testing and fabricating facilities are at your disposal. Write or phone today for immediate attention. Blaw-Knox Company, Advanced Products Division, Pittsburgh 30, Pa. Phone, STerling 1-2700.

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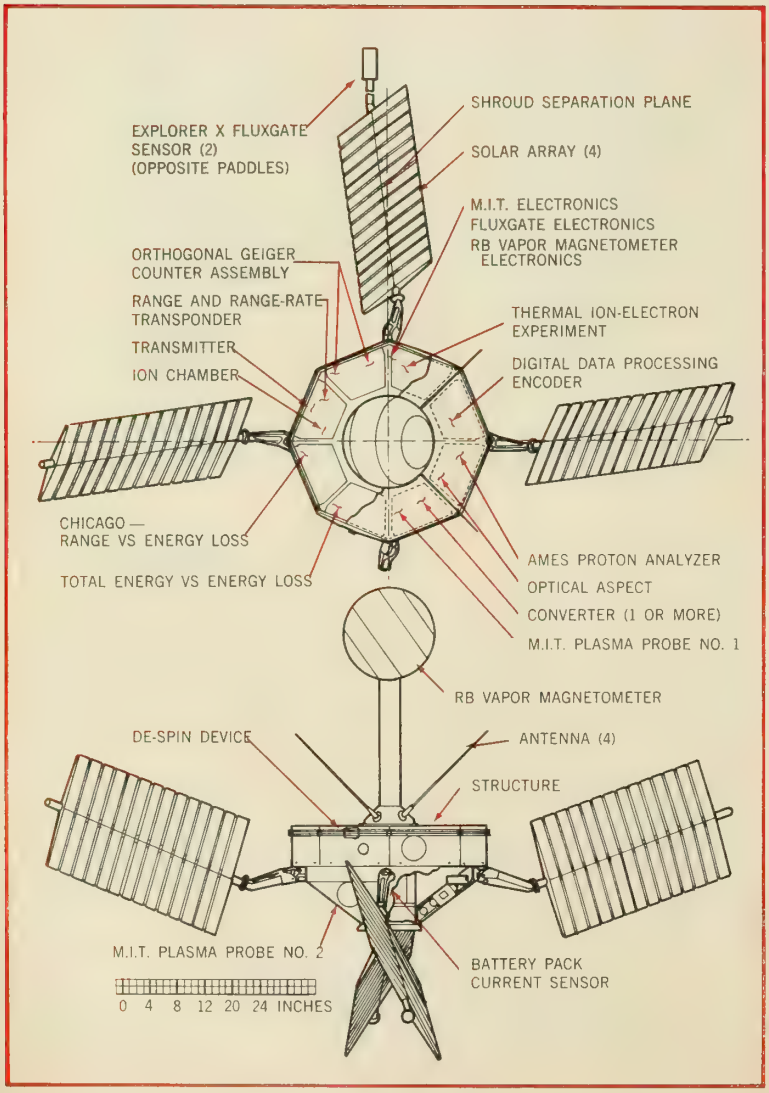
Circle No. 6 on Subscriber Service Card

IMP Solar Flare Data May Save Lives

Satellites developed by NASA's Goddard group will also investigate Earth-Sun relationships

by William Beller



SCHEMATIC of Goddard's Interplanetary Monitoring Probe (IMP).

THE LIVES of some future *Apollo* astronauts may depend on how successfully a newly disclosed monitoring satellite called *IMP* gathers data from cislunar space.

On the lookout for proton and other solar radiations, an *IMP* is intended to be in orbit at all times—starting from the scheduled first launch in the second quarter of 1963.

A prime purpose of *IMP* is to help develop a way to anticipate solar flares. Only a statistical method—described last year by University of California scientist Dr. Kinsey A. Anderson (M/R, Aug. 7, 1961, p. 30)—has so far been able to predict them with fair accuracy. However, when *Apollo* astronauts are in flight, each unpredicted solar flare can cause three deaths. Therefore the National Aeronautics and Space Administration considers *IMP* an essential input to the *Apollo* program.

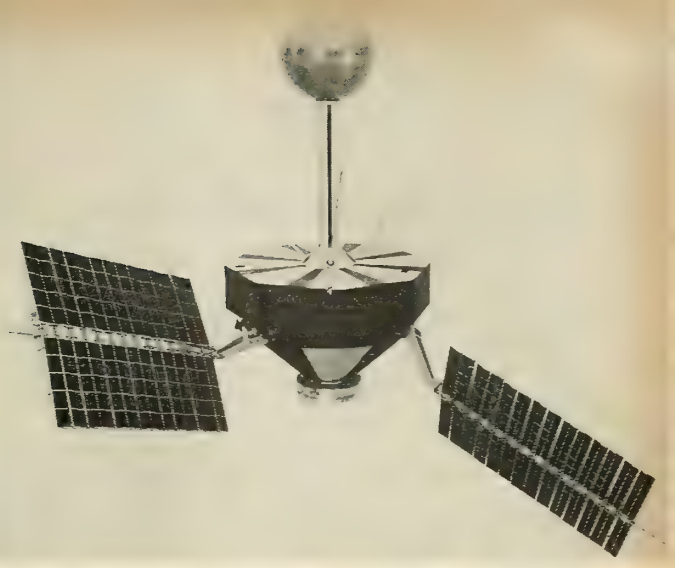
• **Name a misnomer** — *IMP*, an acronym for *Interplanetary Monitoring Probe*, describes a family of identical satellites designed to be neither interplanetary nor probes. They will have expected lifetimes of one year, and will be sent on highly eccentric orbits reaching initial apogees of about 150,000 nautical miles and perigees of 110 nautical miles.

Other purposes of *IMP* are to get information about solar-terrestrial relationships and give designers more experience in building relatively simple, lightweight and unstabilized vehicles able to explore cislunar and interplanetary space.

To do this, each *IMP* will hold eight scientific experiments aimed at getting data on the solar wind, cislunar magnetic field, and the intensity and charge spectra of cosmic rays.

IMP is an in-house project of NASA's Goddard Space Flight Center. Although the official go-ahead came

# of Astronauts



Model of IMP showing only two of four solar panels.

only two months ago, the design of *IMP* is almost ready to be frozen and some hardware is already being built. Present plans call for experimenters and instrumenters to deliver prototype hardware in September.

The program prescribes three *IMPs,* the second and third to be orbited on successive years after the hoped-for first successful launching next year, according to G. W. Longanecker, Assistant Project Manager. The satellite is described as spin-stabilized, equipped with solar-cell power supply, and using a digital-data processor to ensure effective use of the available telemetry bandwidth.

• **To ride improved Delta**—Weighing a little less than 125 lbs., the *IMP* is in the "small satellite class." Thus it can be launched by a *Delta,* somewhat modified to send the orbiter on its highly eccentric path.

Outwardly, the launch vehicle will be unchanged from the conventional *Delta.* However, the Douglas booster will be a "Block-2" *Thor,* giving 165,000 lbs. thrust instead of the nominal 150,000 lbs; the Aerojet second-stage propellant tank will be extended, but the ABL-X248 third stage will be left alone.

Longanecker describes *IMP* as a step beyond *Explorer X* and *XII*—but costing no more: it takes what it can from its predecessors and what it cannot, it prorates on its successors.

The satellite's structural design is taken directly from *Explorer XII.* The rubidium-vapor magnetometer was used on *Explorer X.* Moreover, much of the instrumentation was proven on previous Goddard satellites. The PFM telemetry system, designed by Robert Rochelle, head of Goddard's Flight Data Systems Branch, was used on several satellites including *Explorer X* and *XII* and the forthcoming *S-51.*

In every instance, a proposed *IMP* experiment was either on *Explorer X* or *XII,* or is being developed for *EOGO, Ranger,* or *Mariner.*

Paul Butler, Project Manager, and Dr. F. B. McDonald, Project Scientist, prescribed that *IMP* scientific experiments be stored in standard modules which could be pulled out like drawers from the satellite's octagon structure. In this way, there will be none of the usual fussing around if an experimenter wishes to make changes in his module or wants to substitute another.

IMP will carry three categories of experiments: cosmic ray, solar wind and magnetic field.

• **Cosmic-ray experiments:**

—Range versus energy loss. Experimenter—Dr. J. A. Simpson, University of Chicago. Instrument is designed to recognize solar-proton or alpha-flare events. Protons with energies between 100 kev and 200 mev will be measured. To do this, a range-energy loss telescope using between 25 and 40 solid-state detectors along with a 64-channel pulse-height analyzer and range logic similar to that in *Mariner* will be used.

—Total energy versus energy loss. Experimenter—Dr. F. B. McDonald, Goddard. Experiment furnishes precision separation of protons, electrons, alpha particles and heavy primaries and is sensitive down to very small flux values, thereby providing a means of determining energy and charge spectra. To help do this, a thin "energy loss" crystal is placed in coincidence with a thick total-energy scintillator.

—Neher-type ion chamber. Experimenter—Dr. Kinsey Anderson, University of California. Instrument measures total ionization produced per unit time in a unit volume of standard density air. It has been flown on *Explorer VI* and *Pioneer V.*

—Orthogonal Geiger-counter telescope array. Experimenter—Dr. F. B. McDonald. Two Geiger-counter telescopes mounted at right angles to each other—one along spin axis—will give data on the isotropy of solar-proton events and of cosmic-ray modulation.

• **Solar wind experiments:**

—Low-energy proton analyzer. Experimenter—Dr. Michael Bader, NASA, Ames Research Center. The proton concentrations as a function of kinetic energy are determined by admitting the protons through a slit of known dimensions in the satellite skin. A variable curved-plate electrostatic analyzer separates the particles according to their energy.

—Plasma probe. Experimenter—Dr. Herbert Bridge, Massachusetts Institute of Technology. Plasma probe will measure the flux of low-energy positive particles in particle-velocity increments between 10 km/sec. and 100 km/sec. Charged particles entering a 6-in.-dia. surface area are passed through a series of grids set at potentials which reject electrons and low-energy positive particles. The voltage on one grid is modulated at potentials between 5 and 3000 volts. The number of charged particles reaching the collector is detected with an electrometer circuit.

—Thermal ion and electron experiment. Experimenters—R. E. Bourdeau and G. P. Serbu, Goddard. This experiment measures the concentrations and temperatures of thermal electrons, and the concentrations, masses, and temperatures of thermal ions. One sensor with different modes of operation will be used, and will be a charged-particle trap similar to those flown on *Explorer VIII.*

• **Magnetic field studies:**

—Magnetometer experiment. Experimenter—Dr. Norman Ness, Goddard. A Rb magnetometer will measure the total vector magnetic field independent of orientation; and two fluxgate magnetometers will be used to determine the direction of fields in regions where field strength is less than 30 gammas. ¤

AME Presses Deposition Development

THE FULL POTENTIAL of vapor-deposited microcircuitry techniques will not be realized unless the circuit designer and the fabricator function together as a team from the beginning, says M. A. Karp, president of Advanced Microelectronics Co.

In these techniques, Karp notes, the main problem is to treat such circuits as collections of components—where the overall function of the circuit should be the criterion.

The AME executive says circuit designers must get away from component tolerances and conceive of whole circuit tolerances—an admittedly difficult task. The question then is how to define circuit tolerances: Karp says research efforts along this line should be under way right now.

AME was organized in August, 1961, by Karp, who was formerly a member of Dr. W. Liben's microelectronics group at Johns Hopkins Applied Physics Lab.

The firm is currently marketing a line of three digital modules out of a projected total of 8 production units—a dual inverter, a multivibrator and a thin film flip-flop.

But the main interest is in custom-designed circuits using evaporation deposition techniques.

Film deposition is carried out in an 18-in. bell jar vacuum unit built by NRC Equipment Corp. A "Lazy Susan" mask holder is used. A complete circuit is deposited during each pull-down without breaking the vacuum. This prevents the formation of an oxide or any other coating on the substrate as the films are being built. Most of the techniques involved are proprietary.

Masks are prepared by another company, but AME expects to have this capability eventually. The main reason is economics: one-circuit requests are prohibitively expensive—a certain number of a particular circuit must be deposited from one mask to bring the mask cost-per-unit down to a reasonable level.

AME experts "breadboard" their circuits before mask preparation. This affords a quick design check on the circuit and outlines problem areas.

• **Epoxy joining** — The one-inch-square modules are bonded to connectors with conductive epoxies. This method of joining has not been universally accepted, and AME had initial problems with the plastic. It was discovered that the conducting constituent was not evenly distributed through the material—resulting in conductor-rich and -poor areas.

The epoxy manufacturer corrected this, and AME has had no trouble since. The resin is easy to mix and apply. The adhesive is so tough the connector itself will fail before the bond.

In every case, the unit is encased in a clear silicone envelope (Dow Corning Silgard) before potting. This prevents the potting compound from touching the deposited circuits—and AME can even recover circuits after potting.

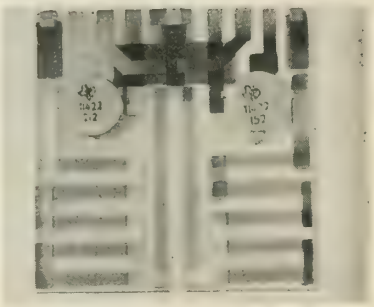
The firm has thermal compression bonding equipment and would like to work directly with transistor chips in building their circuits. This would reduce thickness considerably. An alternative route would be to bury the transistor in the glass subtrate; this is under investigation.

• **Ceramic too rough?**—Glass substrates are used by AME, but ceramics have been studied and are still in the picture. The chief advantage in a ceramic substrate is heat dissipation. But the surface roughness characteristics of the material is a drawback. In a custom job, AME would use ceramic substrates only if the firm designed the circuit. But if a 5% resistance has to be held, glass is the preferred choice.

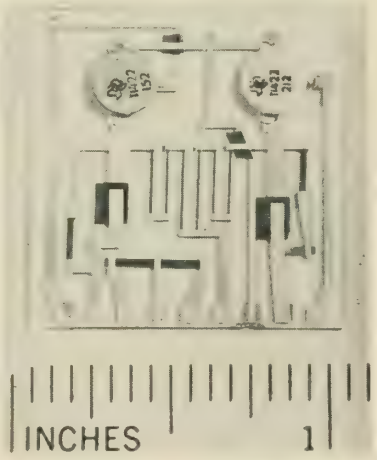
The firm can deposit the passive circuitry required in the 100,000 ohm resistance range quite conveniently. Higher ranges such as 500,000 ohms can be handled, but less easily. The same is true for ranges below 50 ohms. The convenient capacitor range is 1000 micro-microfarads. Less convenient are the 5000- and 10-micro-microfarad levels. AME experts feel they can handle a 1-microfarad capacitor—but not too many of them.

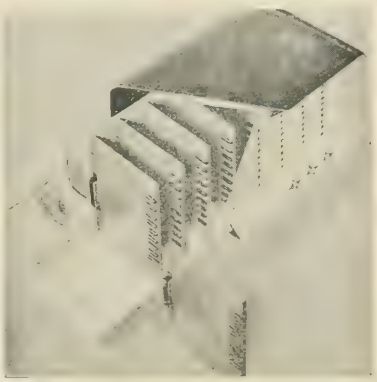
No inductor deposition has yet been done. Karp says when they reach the 10- and 100-megacycle ranges, this capability will be added.

The vacuum deposition unit is located in a temperature-humidity-controlled room with ample space for three similar units. The firm is also eyeing ultrasonic welding as a possible follow-on to the conductive epoxy joining method. ⁂



TOP UNIT is breadboard design of the AME dual inverter. Lower photo shows the production deposited circuit. Breadboard units are masked out with hand-cut forms to check the design.





FAN-OUT boards mounted in this chassis let system designer use the same microcircuits in system breadboarding that will go into the finished product.

Hybrid Guidance Developed for Space

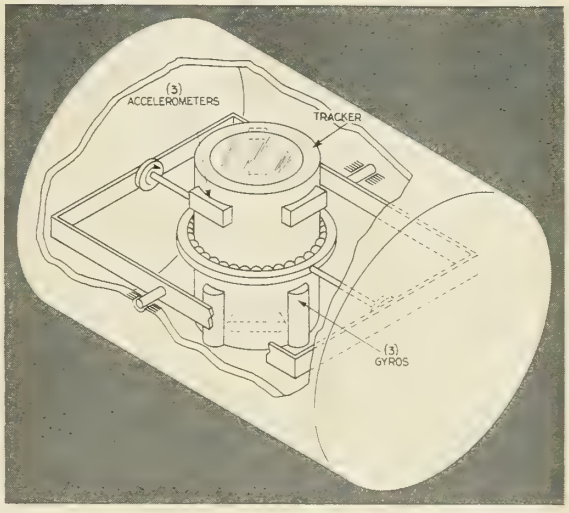
A HYBRID stellar-inertial guidance system is being proposed for use in military space vehicles assigned support missions.

The system, which is designed around a miniature stellar-inertial platform and a general-purpose vehicle computer, employs a minimum number of gimbals to isolate the star tracker element. It uses body-mounting techniques to strap the inertial elements directly to the celestial tracker.

Project engineers at the Kearfott Division of General Precision, Inc., Little Falls, N.J., developers of the guidance package, say the hybrid body-mounted technique will yield greater accuracy than a conventional strapped-down system, while also employing stellar monitoring to reset the inertial navigational network. Power and weight requirements, they add, are also expected to be lower than those of straight inertial systems.

Kearfott engineers feel that the device, with its inherent attitude reset capability, is best suited for cislunar missions of extended duration calling for operation independent of extensive ground tracking and navigation stations.

The system is called capable of providing boost-phase guidance, attitude and velocity reference for rendezvous, and re-entry guidance to a specific landing area. ⌘



HYBRID STELLAR - INERTIAL guidance system, developed by the Kearfott Div. of General Precision, Inc., employs gimballed stellar tracking element and strapped - down gyro and accelerometer inertial components. The system is currently being proposed to the military for use aboard spacecraft assigned extended cislunar space logistics missions.

New MIT Cooler

Air Products Device Allows Remote Operation

A NEW closed-cycle helium-cooled cryogenic refrigerator, designed for both field and laboratory use, is now in service at the Lincoln Laboratory of Massachusetts Institute of Technology.

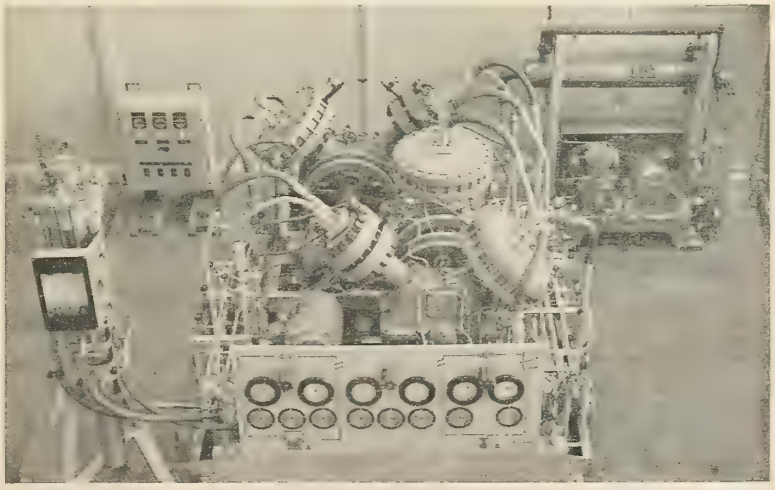
The device will be used primarily for maser cooling operations. However, it is also reported to be adaptable for cooling superconducting magnets and cryogenic computer elements which require liquid-helium temperature controls.

Developed and built by Air Products and Chemicals, Inc., of Allentown, Pa., the unit employs a multi-fluid (helium, hydrogen, and nitrogen) cascade cycle to provide cryogenic refrigeration of ¾ watt at −452°F (4.4°K). The fluids used in the new system are cooled to their liquefaction temperatures by the Joule-Thomson effect (expansion from high to low pressure).

According to the developers, the system has been engineered to allow remote operation and flexibility in the physical arrangement of the cryostat and compressor components, and has also been designed for trailer transport for field use.

Closed-cycle systems of this type are considered essential utilization in the field. In most cases it is difficult and impractical to replenish liquid helium which evaporates from open cooling system.

The refrigerator employs modified non-contaminating metal-diaphragm compressors, coiled-fin heat exchangers, and a simple cryostat design. It is reported capable of extended unattended operation. ⌘



TEMPERATURE of maser cooling chamber in cryostat (at left) is kept at 4.4°K by helium atmosphere in new MIT closed-cycle refrigeration unit. Compressor package is shown in center, with water-cooling unit in right rear.

French Touting MATRA 530, AS-30

MATRA'S new 530 air-to-air solid missiles going through assembly line. French call it "infinitely superior" to Sidewinder.

VAUTOUR fighter carries MATRA 530. Its infrared and electromagnetic homing has scored 80% kills "in worst conditions."

FRENCH SOURCES in Paris revealed last week that several first-generation missile programs have been phased out, new ones have been committed to production, and several R&D programs will enjoy increased funding support.

Since missile activities were centralized under a Ministry for Armaments, headed by General Lavaud, the French have come up with a low-cost antitank weapon and a serious competitor to America's air-to-air *Sidewinder*.

While military R&D on bigger solid-fuel motors is closely allied to France's space plans (M/R, March 12, p. 35), the total effort will continue to have a high priority—and there will be concentration on new-generation smaller missiles, which the French expect to continue successfully exporting to NATO.

• **Potent Entac**—The newest antitank missile, *Entac*, costs only $600 per unit, it was learned, and its effective 6500-ft. range may mean that massive tanks will no longer spearhead blitzkriegs.

Some 10,000 *Entacs* have been turned out by Atelier de Construction de Puteaux for DEFA (French Army R&D agency) and the French say two tests series have been conducted in the U.S. *Entac* replaces the earlier Nord *SS-10*, but not the longer-range, heavier-payload Nord *SS-11*.

Nord's *AS-12* will be used on anti-armour and surface-target missions of the Navy's Alize and Brequet Atlantic aircraft and by fast escort warships as a defense against torpedo boats.

Range of the air-launched *AS-12* is about 30,000 ft.; ship-launched, the weapon is effective at about 20,000 ft. All-up weight is 160 lbs.

• **Air-launch entries**—Two new air-launched missiles emerged from target tests with high honors. One is the highly regarded *AS-30*, whose total warhead weight is half its overall 1100 lbs.

The design can accommodate either a 500-lb. military conventional payload or a nuclear capability. Three types of guidance are mentioned for the airborne system—radio command, all-inertial with preset trajectory, or a new optical reference, partially inertial system.

"Infinitely superior to *Sidewinder*" (which the French have been using) is the French comment on the MATRA *530*—a 375-lb. air-to-air solid missile which can home its 65-lb. warhead into or against an enemy aircraft over three miles away.

Replacing its predecessor the *511*, MATRA's new *530* has proven its infrared and electromagnetic homing in numerous test series and, the French report, "under the worst firing conditions it will score 8 kills out of 10 tries."

It appears that if the *530's* performance is adjudged elsewhere with anything approaching French optimism, some NATO members may decide to take a hard look at current plans to use *Sidewinders* coming off NATO production lines in Europe.

• **Other weapons**—In another area, the *AS-20* appears to have been phased out without ever attaining full production—although a few units of the 270-lb. missile have seen service on French naval aircraft. It was limited by its 6.5-mile range and its tele-radio type guidance, which prevailed in many early French missile designs.

The Raytheon *Hawk*, a NATO production item in France and in other European countries, is destined for anti-aircraft deployment around several vital French centers. Each battery will consist of 18 missiles, three to a mobile ramp.

Warships up to frigate size will carry the surface-to-air *Masurca*. Its effectiveness against Mach 2 aircraft between 60 and 90,000 ft. is compared to that of *Tartar*.

A special multiple-load cylinder permits 20 3500-lb. *Masurcas* to be adequately placed for effective loading and handling aboard ship. Target illumination and homing techniques have been added to its alignment/feed-in data design.

Monica is being used as a Naval training missile, and *Parco* for Army training. However, the French say that fabrication of the *Monica* and the *Parca* has been abandoned. ⌗

Semiconductor Prices Stabilizing

A two-year sharp decline in semiconductor prices is showing signs of leveling off. Raytheon's Stuart D. Cowan, VP-Commercial Marketing, told a California audience that the chaotic condition in the transistor and diode business may have hit its low last year when the price of a single transistor type fell 40% within a few hours. He cited the reasons for the "price debacle" as: (1) Many manufacturers didn't know actual costs; some still don't; (2) Pricing decisions were delegated to junior levels when they should have been a function of top management; (3) Venture capital companies supplied funds on the flimsiest plans of well-meaning technical people who frequently lacked the requisite management background and (4) Some early pricing had been unrealistic and gave certain suppliers a false impression of margin leverage. "There are signs that the seemingly endless flow of risk capital is at last drying up," he said. A *Wall Street Journal* survey indicated semiconductor price stabilization was becoming widespread throughout the industry. Sylvania Electric Products said it has raised some prices this year and an official of Motorola Semiconductor Products, Inc. said "There has been a stabilization of prices. . . . The market is much healthier than it was a year ago."

New Names in The Industry

Twin Industries Corp. is the new name for Twin Coach Co. The change was made to better reflect company activities, which include GSE for missile programs. . . . *Geo Space Electronics Co. was formed in Houston to do research, development and manufacturing of electro-mechanical and low frequency instrumentation in the geophysical sciences. President is Louis B. McManis. The company will also do work in sonar, ASW, telemetering and general low-frequency instrumentation.* . . . Scientific Analysis Corp. was formed in Concord, Mass., to provide advanced planning and systems analysis and evaluation—primarily communications, information, surveillance, and command and control.

New Industry Facilities

Burroughs Corp. is building a $500,000 experimental facility at Colorado Springs, Colo., to be operated for the USAF 425L System Program Office of the Electronic System Division. First floor of the 50,000-sq.-ft. plant will be devoted to a test facility for engineering evaluation and training of personnel. The second floor will house administrative and engineering offices. . . . *Chicago Bridge and Iron Co. moved into its new executive offices near Chicago. A three-story research laboratory wing is nearing completion.* . . . Timely Technical Products, Inc., will build a new manufacturing plant in Montville, N.J., designed to the technical requirements for processing of fluorocarbon products and other plastics. Occupancy is scheduled for the first of November. . . . *Thompson Ramo Wooldridge Inc., RW Div., was awarded a $450,000 DOD contract to assist in design of an advanced computer-supported damage assessment center. It will, in peacetime, analyze hazards and vulnerabilities of worldwide military forces and economic resources and, under wartime conditions, assess and report to DOD the damage to these forces and resources.* . . . Electronic Specialty Company fabricated a large support structure for parabolic reflectors of a space simulator being built for JPL. When completed, it will duplicate solar illumination in a near-vacuum atmosphere and will be used for testing spacecraft models over a 150-mile altitude. . . . *Electronic Engineering Co. of California will open a Computer Tape Conversion Center in Santa Ana, Calif. The center will have the initial facility for translation of 10 punched paper tape languages into magnetic tape adaptable to IBM, Burroughs, RCA, and Remington Rand computers.* . . . Consolidated Systems Corp. will move all company operations to Pomona, Calif. A 150,000-sq.-ft. facility will be built to company specifications in the Pomona Valley Colleges Research and Development Center. . . . *Utrad Corp., division of Litton Industries completed new production facilities at Huntington, Ind., for increased manufacturing space for precision transformers, electro magnets and deflection components.* . . . Nuclear Research Associates moved its manufacturing, research, development and office facilities to larger quarters in Long Island City, New York.

International News Briefs

Contraves of Switzerland, an Oerlichon subsidiary, and California Computer Products have been informally discussing possible mutual marketing arrangements. Contraves would sell CalComp digital equipment in Europe, and CalComp would handle Contraves systems in the U.S.

News of Mergers and Acquisitions

The Ex-Cell-O Corp. has purchased Willey's Carbide Tool Co., Detroit, which will become part of Ex-Cell-O's Industrial Gear and Tool Products Group. The acquisition will complement the parent company's expendable tool line. . . . *Aircraft and Missile Consultants acquired Aircraft & Missile-Films to produce training films, progress reports, documentaries and technical sales films for military, industrial and commercial use.* . . . Servo-Tek Products Co., Inc., acquired Aerosonic Electric, Inc., Clearwater, Fla. Aerosonic products will be manufactured by a new organization, Servo-Tek Marine, Inc. in a 10,000-sq.-ft. plant nearing completion at Clearwater. . . . *Systron-Donner Corp. acquired 85% of the outstanding stock of Electromagnetics, Inc., Los Angeles, producer of magnetic heads, magnetic storage discs and similar devices for digital computers and data handling instrumentation. The acquisition was made to widen S-D's product line.* . . . Microwave Communications and Facilities, Inc., Dallas, will merge with Recreation Enterprises, Inc., Kansas City, Mo., and operate under the corporate name of Micom Inc. Merger will permit expansion of Microwave sales, a company spokesman said.

For Apollo project . . .

NASA To Add About 15 Astronauts

NASA's Project *Apollo* program will ultimately require a total of about 20 astronauts for its manned flights to the moon.

The total scope of the space agency's astronaut program was disclosed by NASA officials as they announced that between five and ten new astronauts would be chosen late this year to join the current seven Project *Mercury* astronauts. Another group will be selected in the 1964-65 period.

Selection of the new group will be limited to experienced jet test pilots with engineering and scientific training. Civilian, as well as military pilots, will be considered, NASA said.

The new group will participate in support operations in Project *Mercury* and will join the present astronauts in piloting the two-man *Gemini* spacecraft.

After the *Gemini* program is completed, the space agency said, some of the pilots may act as spacecraft commanders on *Apollo* missions.

• **Process**—Here is the timetable for selections:

—Applications from any individual meeting the qualifications will be accepted by the Director of the Manned Spacecraft Center, Houston, Tex., until June 1, 1962. The aircraft industry, military services, and other government agencies will be requested to recommend pilots best qualified for this work.

—In July, pilots meeting the qualifications will be interviewed and given written examinations on their engineering and scientific knowledge.

—After that screening, selected applicants will be given a thorough physical examination by a group of medical specialists.

—Final selection will be made in the fall of 1962.

• **Prerequisites**—Five qualifications have been established for the applicants.

1. The candidate must be an experienced jet test pilot and preferably be engaged in flying high-performance aircraft.

2. He must have attained experimental flight test status through the military services, the aircraft industry, or NASA—or must have graduated from a military test pilot school.

3. He must have earned a degree in the physical or biological sciences or in engineering.

4. He must be a United States citizen, under 35 years of age at the time of selection and six feet or less in height.

5. He must be recommended by his present organization.

The training program of the new astronauts will include work with design and development engineers, simulator flying, centrifuge training, additional scientific training and flights in high-performance aircraft. ⁂

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AERODYNAMICS: *experienced engineer to perform aerodynamics analysis of missile configurations to determine performance, stability and air loads.*

If interested and qualified, please forward your resume to Mr. William O'Melia, Bedford R & D Center, Raytheon Company, Bedford, Massachusetts.

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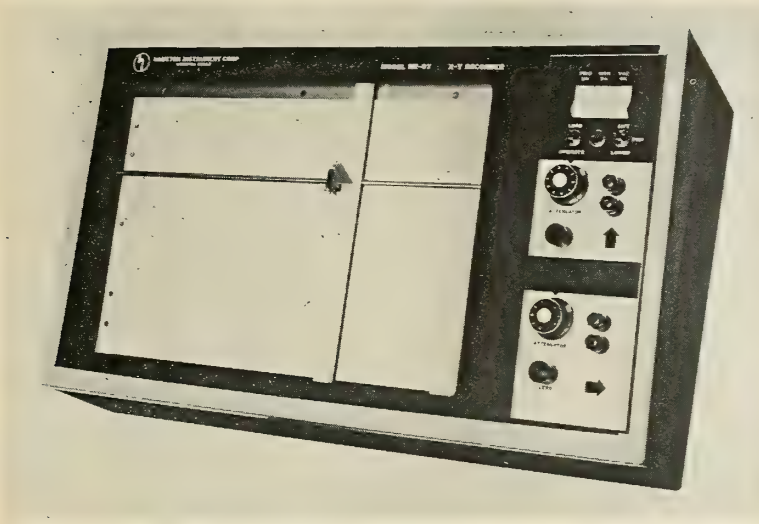


New Product of the Week: Axis-Independent X-Y Plotter

THE MODEL HR-97 X-Y plotter is available from Houston Instrument Corp. Housed in a bench case, it has vacuum paper hold-down, Zener references, 15 in./sec. pen speed both axes, and over 600 in./sec.^{2} acceleration. Each axis is independent of the other, with amplifiers that are interchangeable and contain independent power supplies. Maximum sensitivity of 1 mv/in. can be readjusted with a continuously variable attenuator for exact and known full-scale calibration. Combination of a new type of snap-in pen that uses replaceable ink cartridges and a high-speed electric pen lifter allows point plotting up to 20 points/sec.

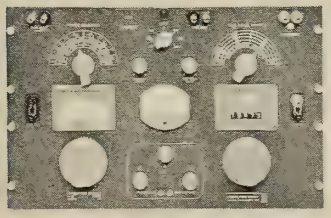
A built-in time base is an optional feature. Sweep rates of 1.5 sec. to 15 minutes full-scale can be directly set with a continuously variable control.

Circle No. 225 on Subscriber Service Card

Impedance Bridge

A universal impedance bridge with in-line readout and a nominal accuracy of 0.1% has been developed by the General Radio Co.

Known as the Type 1608-A, the instrument can measure R, C, L- and G, quantities being indicated directly on an in-line readout scale with automatic decimal-point location and automatic indication of units. D and Q information can be read directly on a dial.



A 1-kc transistor RC oscillator serves as the internal ac source. A transistor amplifier with a twin-T RC filter, for selectivity, is used as an internal ac detector. Self-contained, the bridge measures 19-in. x 13-in. x 11-in. overall.

Circle No. 226 on Subscriber Service Card

Signal Tracer

A pen-size signal tracer that locates hum, oscillations, ground loop, printed circuit breaks, and other common defects, has been introduced by Don Bosco Electronics, Inc., subsidiary of Howell Electric Motors Co., Inc. It detects and demodulates any low-level, microwatt audio or modulated radio frequency signal, and then amplifies it 1000 times in a button earphone. The signal may also be observed on a scope, using an optional plug-in scope adaptor. It is useful for running continuity tests on capacitors, transistors, and other components.

Circle No. 227 on Subscriber Service Card

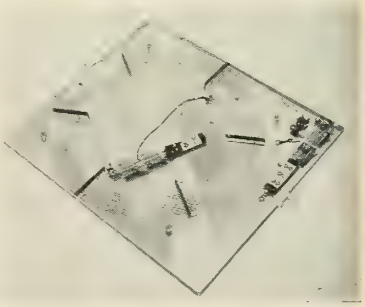
Function Monitor

Electronic Control Products, Div. of Electronic Fabrication Laboratories, has announced production of the Sentinel Function Monitor for control of processing and flow activities in a wide range of industries. The unit monitors such functions as heat limits, pressure limits, flow limits, and peak load, and scans through as many as one thousand function states in slightly more than one second. Any function in excess of the pre-set limit triggers an audible alarm. The malfunction is indicated on the control panel, and a panel clock stops at the exact time of the alarm.

Circle No. 228 on Subscriber Service Card

Long-Length Data Storage

Deltime, Inc., announces a new, long-length delay line of the magnetostrictive design, suitable for data storage functions in computer systems at increased frequencies. The line provides a 5-millisecond delay with a pulse repetition rate of 1 MC/S with a return-to-zero operation. Measuring only 11 in. x 12⅞ in. x ½ in. thick, it operates on an input voltage of 16 volts at 80 ma



maximum. Input pulse width at the 10% point is .4 to .5 usec. maximum. Signal-to-noise ratio is 10:1 minimum for a single pulse. Output voltage is 7 mv minimum. Temperature coefficient of delay is 5 PPM/°C from 0° to 50°C, and it is sealed against ambient humidity and stray magnetic fields.

Circle No. 229 on Subscriber Service Card

Vacuum Tweezer

Ultrasonic Laboratories, Inc., has added to its line a tweezer designed for split-second pickup of minute component parts for assembly, without damage to critical surfaces.

Two advantages of this method are speed in handling and elimination of defects caused by scratching, marring or pinching. Shaped like a pencil and

provided with finger-tip control, it uses as its source of energy a U.L.-approved portable vacuum generator operating on 110 volts a-c.

Circle No. 230 on Subscriber Service Card

Noninductive Capacitor

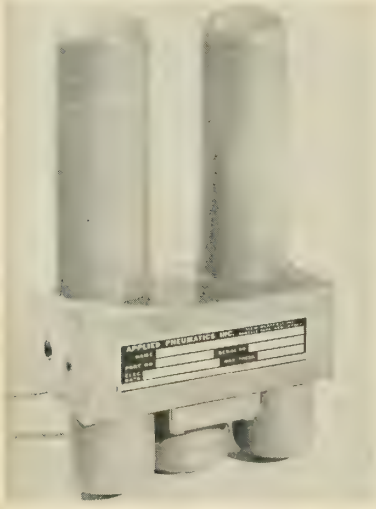
Electron Products, division of Marshall Industries, announces a high-voltage noninductive capacitor, available in an encapsulated rectangular package, which meets the humidity, temperature and immersion cycling of MIL-27287 (USAF) per MIL-STD-202B, Methods 102A, 103A. Designed for use in temperature range of −55° C. to +125°C, it extends foil construction.

Size reduction has been accomplished by elimination of the metallic case and large, bulky stand-off terminals. It is available from 2000 VDC to 30,000 VDC ratings in capacity values from .001 mfd to .20 mfd.

Circle No. 231 on Subscriber Service Card

Miniature Air Dryer

An automatic miniature air dryer capable of producing up to 10 SCFM of dry air is available from Applied Pneumatics, Inc. The small, lightweight unit eliminates the need for in-line filters, strainers, and water separators, and will operate indefinitely without maintenance, service or parts replacement.



It has a built-in pre-filter and automatic dump, provides dew points to −90°F, and is suitable for use with ⅛, ¼, and ⅜ N P T pipe. The dryer is useful for instrument air drying, laboratory and scientific work, or gas sampling.

Circle No. 232 on Subscriber Service Card

Power Supply

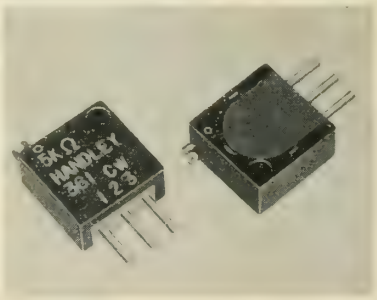
A dc power supply capable of remote programing, remote sensing and output current limiting is available from Hewlett-Packard Co.

The solid-state power supply, Model 726AR, provides a full 2-amp current capacity, and a regulated output of 0 to 45 volts. The output voltage changes less than 2.5 mv for 10% line voltage variation, and less than 5 mv when the output current changes anywhere from 0 to 2 amps.

Circle No. 233 on Subscriber Service Card

Potentiometers

Handley Trimmer Potentiometers is marketing 3/8-in.-square trimmers in a wide range of values. Featuring a one-piece anodized aluminum case, they have a power rating of 1 watt at 50°C,



dereated to 0 watts at 150°C. Available models meet all the electrical and environmental specifications for Mil-Std 202-A, Mil-Std 5272 and MIL-R-27208. Standard resistance values range from 50 ohms to 20K ohms. Turns ratio is 25:1, with stops and slipclutch optional.

Circle No. 234 on Subscriber Service Card

WWV Preamplifier

Aerospace Research, Inc. announces the development of the PA-1020 Preamplifier, designed for mounting at the antenna, and for optimum reception of WWV standard timing signals. The unit is encased in a weatherproof 3-in. x 4-1/2 in. x 5-in. box, and provides a gain of 40 db at 5, 10, 15 and 20 mcs simultaneously. It is sharply tuned, and exhibits a Q of 100 at each frequency with no significant spurious responses. Imput and output impedence is 50 ohms; circuitry is transistorized.

Circle No. 235 on Subscriber Service Card

new literature

POWER RESISTOR DECADES — Clarostate Mfg. Co., Inc., announces a catalog on power resistor decades. It is the first published information on the rack-mounted version of the well-known Clarostat decade, which permits the accurate decading of resistance under actual heavy-load conditions in test, experimental, or component circuitry. Copies of the new catalog are available upon request.

Circle No. 200 on Subscriber Service Card

METALLIC SEAL RINGS—A bulletin on high-performance Metallic Seal Rings for aerospace applications has been released by the Metal Products Div. of Koppers Company, Inc. The brochure includes information on specification and selection, as well as performance data and mating parts requirements. There are tables on ring materials and recommended usage.

Circle No. 201 on Subscriber Service Card

ELECTROMAGNETIC CONTROLS —A 64-page technical catalog providing application information, construction details, operating features, related engineering information and prices on electromagnetic controls and timing devices, is available from Zenith Electric Co. Equipment is illustrated throughout. Wiring diagrams clearly illustrate circuit hookups, and dimensional drawings and tables are provided. It also includes information on ground detectors, remote control switches, program clocks and special timing controls.

Circle No. 202 on Subscriber Service Card

MINIATURE CABLE — A 14-page brochure provides complete information on the recently developed 1/8-in.-O.D. 5000-volt cable. Included are the ASTM Standard Specifications, tests, tables relating to this type PFTX-5000-20. Engineers requiring a miniature cable with high corona threshold, for use where temperatures range from −80° to +200°C, should find this reference helpful.

Circle No. 203 on Subscriber Service Card

CIRCUIT BOARD RETAINERS — Birtcher technical data sheet, 4 pages, describes new PCB-Trainers for 1/16-in. and 3/32-in. printed-circuit boards that will hold up to 1/4 lb. of circuitry components under 30-g shock in modules and provides an excellent ground and thermal path. Data includes a dimensioned drawing and photograph of the retainer, general description, certified shock and vibration test results, sizes available, and a list of optional finishes.

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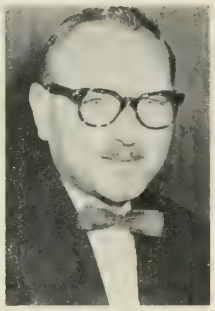
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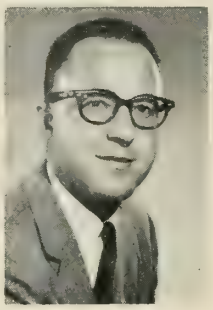
STONE

SANDERS

HAWKINS

Theodore W. Knacke: Joined Northrop Corp—Ventura Division, as chief of the technical staff for the paradynamics section. He will work on design and development of recovery systems for space vehicles, including Project *Apollo* Earth landing system.

Dr. H. Gunther Rudenberg: New member of Arthur D. Little, Inc.'s senior staff, in charge of development of new-generation semiconductor devices and related research and engineering problems.

Roger W. Honebrink: Joined Giannini Controls Corp., Duarte, Calif., as general manager of the Systems Division.

William P. Munger: Appointed director of Hydraulic and Electronic Research of the American Brake Shoe Co., New York, N.Y.

Charles E. Crowley: Appointed general manager of the support division at the Martin Co.'s Middle River, Md., plant. He was formerly industrial relations director at the plant.

J. R. Ballinger: Joined Packard Bell Computer Corp. as manager of the Industrial Systems Dept., Anaheim, Calif.

Louis J. Metevier: Promoted to assistant general manager of Hallicrafter Co.'s Aerospace Division. He was previously manager of the company's electronic countermeasures program.

Robert P. Hardin: New public relations manager for the Northrop Corp.'s Anaheim, Calif., facility. He was formerly with the corporate public relations department of Hughes Aircraft Co.

Leonard C. Wholey: Appointed manager of marketing for General Electric Co.'s Rectifier Components Dept., Auburn, N.Y.

Elmer J. Stone: Appointed chief counsel of Douglas Aircraft Co.'s Missile and Space Systems Div., Santa Monica, Calif. Before being named to the newly-created post, he was assistant general counsel for the company. Stone is past chairman of the Aerospace Industries Association legal committee, and is now alternate member of the AIA procurement and finance committee.

Donald A. Sutherland: Appointed president of the American-Standard Controls Div. of the American Radiator & Standard Sanitary Corp., New York. He is former president of the United Aircraft Products Co., Dayton, Ohio.

Dr. Nicholas E. Golovin: Joined the technical staff of **Dr. Jerome B. Wiesner,** Special Assistant to the President for Science and Technology. He was formerly technical assistant to the associate administrator of NASA, and director of the NASA-DOD Large Launch Vehicle Planning Group.

Everett A. Prechel: Appointed director of corporate and contracting policies for Hughes Aircraft Co., Culver City, Calif.

C. F. Pizac: Elected a corporate vice president of Dynalectron Corp., and a vice president and director of its wholly-owned subsidiary, Land-Air, Inc.

John T. Williams: Named director of engineering, The Hallicrafters Co. He will be in charge of active and passive electronic warfare, digital techniques, antenna techniques and engineering services departments. The company also named **Bernard S. Parmet** technical director, and appointed the following engineering managers—**Joseph Wexler** for digital techniques, **Robert C. Baltezore** for passive electronic warfare, **Donald Herling** for antenna systems techniques, and **A. R. Erbe** for engineering services.

Vice Adm. Harry Sanders, Ret.: Named executive vice president of Harbor Boat Co., a division of Chance Vought Corp. Sanders is a member of MISSILES AND ROCKETS editorial advisory board.

Edward Gray: Joined Magnion, Inc. as manager of engineering and manufacturing. He had been project director at Avco-Everett for the past two years.

Willis M. Hawkins: Appointed vice president-engineering, Lockheed Aircraft Corp. He will have general functional and policy responsibility for the corporation's research and engineering programs. Hawkins is now a corporate vice president and general manager of the Lockheed Missiles and Space Company's Space Systems Div.

Frank W. Raymond: Named controller of Litton Systems, Inc.'s Data Systems Div., Salt Lake plant, Salt Lake City, Utah.

W. Scott McGilvray, Jr.: Appointed general manager of Garrett International, S.A., a subsidiary of The Garrett Corp. in Geneva, Switzerland. Previously with the Lockheed Corp., McGilvray replaces **Bryan Sanford Clark.** He will be responsible for development of the company's interests in Europe, the Middle East and Africa.

Dr. Julien Keilson: Appointed senior scientist of Sylvania Electric Products Inc. He has been with the company since 1956.

Meyer Fishbein: Joined Planning Research Corp., Los Angeles, as a senior associate in the systems research division.

Dr. George S. Ansell: Appointed to the board of directors of Ilikon Corp. He is an assistant professor of materials engineering at Renssalaer Polytech, Troy, N.Y.

A. C. Andrews: Elected vice president of The Potter Co., Brookhaven, Miss. He is responsible for manufacturing operations and administrative and sales functions at two company plants.

Donald R. Woolf: Named manager, advanced planning, of the Curtiss Div., Curtiss-Wright Corp., Cladwell, N.J. He joined the company in 1945.

Robert N. Hotchkiss: Appointed technical director of the Systems Management and Engineering department of the Defense Products Div. of Fairchild Camera and Instrument Corp. He was formerly manager of special engineering projects.

James N. Ebright: Named assistant secretary and chief counsel of Aerojet-General Corp. He joined the company as assistant general counsel in July, 1960.

contracts

AIR FORCE

$36,500,036—Thiokol Chemical Corp., Wasatch Division, Bristol, Pa., for continued research and development of the first-stage *Minuteman* solid-propellant engine through flight and qualification tests.

$15,000,000—General Dynamics Corp., San Diego, Calif., for an *Atlas* evaluation and test program at Vandenberg AFB (supplemental contract).

$10,507,000—Martin Marietta Corp., Denver, for fabrication of *Titan II* operational missiles and for installation and checkout of *Titan II* missiles (two supplemental contracts).

$6,997,000—General Dynamics Corp., San Diego, Calif., for ground support equipment for *Atlas* missiles and for work on technical publications for the *Atlas* system (two supplemental contracts).

$6,929,838—General Motors Corp., Milwaukee, for spares for the *Titan* guidance system (supplemental contract).

$3,000,000—Martin Marietta Corp., Denver, for umbilical installation and testing for site activation of *Titan I* (letter contract).

$3,000,000—Western Electric Co., New York City, for fabrication of a guidance system for *Titan* missiles (supplemental contract).

$3,000,000—General Electric Co., Philadelphia, for the *Titan II* re-entry vehicle (supplemental contract).

$2,395,300—Martin Marietta Corp., Baltimore, for kits, spare parts and related data (supplemental contract).

$2,250,000 — Aerojet-General Corp., Sacramento, Calif., for stage II *Minuteman* solid-propellant rocket motors and related equipment (supplemental contract).

$2,141,542—United Technology Corp., Sunnyvale, Calif., for development of advanced components for large segmented solid-propellant rocket motors.

$1,941,353—Guidance Technology, Inc., Santa Monica, Calif., for gyroscopes, spare parts, ground support equipment and related materials.

$1,660,000—General Electric Co., Syracuse, N.Y., for a classified project (supplemental contract).

$1,500,000—Douglas Aircraft Co., Inc., Santa Monica, Calif., for pre-production planning work on the *Skybolt* missile program (supplemental contract).

$1,400,000—Melpar, Inc., Falls Church, Va., for production of nine *GAM 83 A/B* trainers (letter contract).

$1,356,000—Martin Marietta Corp., Orlando, Fla., for guidance systems for the *Bullpup* missile (supplemental contract).

$1,079,396—Goodyear Aircraft Corp., Akron, Ohio, for modification kits, spare parts and related data for the *Mace* missile guidance system (supplemental contract).

$1,065,000—Avco Corp., Wilmington, Mass., for research and development work on nose cones.

$1,000,000—Chance Vought Corp., Inc., Dallas, for advanced technological work on nuclear ramjet engines (letter contract).

$333,190—United Technology Corp., Sunnyvale, Calif., for conducting research in nondestructive testing techniques for large solid-propellant rocket motors.

$292,500—Collins Radio Co., Cedar Rapids, Iowa, for SSB equipment for missiles.

ARMY

$2,300,000—Reeves Instrument Corp., Garden City, L.I., N.Y., for fabrication of Xm1112 fuzes (supplemental contract).

$1,985,000—Raytheon Co., Lexington, Mass., for long leadtime and chassis type items, NATO-*Hawk* program (letter contract).

$1,718,056—Raytheon Co., Lexington, Mass., for *Hawk* field maintenance.

NAVY

$5,647,554—Sperry Rand Corp., Long Island, N.Y., for computers for *Tartar* carrier missiles.

$2,519,700—General Electric Co., Schenectady, N.Y., for procurement of nuclear reactor components for nuclear-powered vessels.

$1,236,897—Sanders Associates, Nashua, N.H., for classified electronics equipment.

$469,858—Elgin National Watch Co. and Mullen Electric Co., Elgin, Ill., for construction of range safety and photographic instrumentation sites, Naval Missile Facility, Point Arguello, Calif.

NASA

$324,664—Vector Corp., New Orleans, for design modifications to facilities at the Michoud Operation space vehicle assembly plant.

$239,891—Research Triangle Institute, Durham, N.C., for probabilistic modeling study for astronautical systems.

$115,000—General Electric Co., Valley Forge, Pa., for development of an experimental unit capable of continuously reclaiming under space conditions the bulk of the oxygen consumed by man.

$97,676—General Dynamics Corp., San Diego, for studies pin-pointing problems of nuclear space flight to the moon and planets.

Vitro Electronics, Silver Spring, Md., for providing the worldwide *Mercury* tracking range with updated capability to receive wide-band PCM telemetry data. No amount disclosed.

AIR FORCE-ARMY-NAVY-ARPA

$6,500,000—Massachusetts Institute of Technology, Lincoln Laboratory, Cambridge, Mass., for research on re-entry physics, acquisition of specialized equipment and research on range measurements (two joint contracts).

INDUSTRY

$2,500,000—Thompson Ramo Wooldridge, Inc., Dage Div., Chicago, from **General Dynamics Corp.,** for production of closed-circuit television systems in equipping 19 *Atlas* missile sites.

$2,000,000—Radio Corporation of America, from **North American Aviation, Inc.,** for development and production of thermoelectric modules for the first orbital nuclear reactor, *SNAP 10A*.

$800,000—Fibercast Co., Sand Springs, Okla., from **Actionflex Co.,** for manufacture of over 100,000 battlefield rocket tubes and indexing rings.

$500,000—Ets-Hokin and Galvan, Inc., San Francisco, from **Boeing Co.,** for maintenance of the communications cable network servicing the Montana *Minuteman* ICBM wing.

$200,000—Airtec Dynamics, Inc., Compton, Calif., from **Martin Marietta Corp.,** for the design and manufacture of portable liquid air vessels.

Westinghouse Electric Corp., Baltimore, from **McDonnell Aircraft Corp.,** St. Louis, for ultra-light weight radar equipment to be used for orbital rendezvous in project *Gemini*. Multi-million-dollar development contract.

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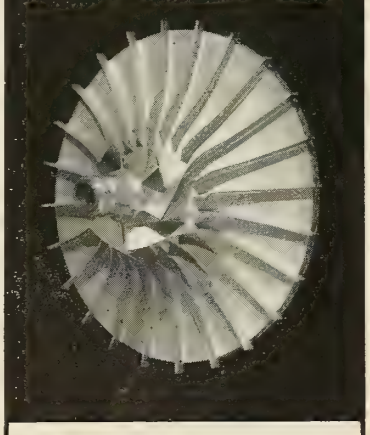

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DOD Appropriations

(Continued from page 14)

dizing DOD research since their indirect costs exceed this figure. The limit on college overhead costs passed after two attempts to cut it from the bill failed.

The bill also reduces funding for the Army's *Advent* communications satellite program by $5 million, as well as denying a total of $6 million for nonprofit corporation contracts.

• **By services**—A breakdown of the appropriations bill included:

—Army: Procurement, Equipment & Missiles—$2.5 billion, down $55 million:
- Operations & Maintenance—$3.1 billion
- Research, Development, Test & Evaluation: $1.3 billion, down $12 million (mainly reductions in *Advent* and Human Factors research)

—Navy: Procurement: aircraft & missiles—$3.007 billion, down $55 million:
- Operations & Maintenance—$2.6 billion
- Shipbuilding & Conversion—$2.9 billion, down $74 million
- Other Procurement—$902 million
- Research, Development, Test & Evaluation—$1.47 billion, down $542,000

—Air Force: Procurement — aircraft $3.5 billion, up $308 million; missiles $2.5 billion, down $41 million:
- Operations & Maintenance—$4.1 billion
- Other Procurement—$950 million
- Research, Development, Test & Evaluation—$3.5 billion, up $42 million.

A new appropriation account for Defense agencies RDT&E totals $439 million, or $12 million less than the requested funding. Included in this account are ARPA, Defense Communications Agency and other agencies not directly tied to one of the services. The DOD emergency fund was again set at $150 million. ⌗

Profits Hearings

(Continued from page 14)

by the 20 largest defense contractors on their total business.

Relating profits to investment in government work for the period 1951 to 1960, Western Electric's profits, after taxes, were about 13% and related to a net worth of about 14%, Smith said.

Smith shied away from a question by Sen. McClellan on what the fee structure on the *Nike-Zeus* might be. The system hasn't been ordered into production, he noted, and therefore he wouldn't want to comment.

• **Army witnesses**—The committee also heard testimony from the chief of Army Ordnance, Lt. Gen. John Henrichs, and Paul R. Ignatius, Assistant Secretary of the Army for Logistics.

Asserting that the Army would use the same contractor team for the production of the *Nike-Zeus* as it did for the other two *Nike* systems, Gen. Henrichs defended the companies and praised them for "the highest level of accomplishment" in fielding *Nike-Hercules* and *Nike-Ajax*.

The Army could reduce the cost of their weapons, Henrichs said, if it took "8 to 12 years" to develop them. However, he added, this would result in weapons "suitable for the Smithsonian Institution and not for war."

In earlier testimony, Army Ordnance officials had admitted that Western Electric had frustrated their efforts to "break-out" parts of the *Nike* system for competitive bidding.

Paul K. Schaeppi, a civilian employee in the Army's Industrial Operations Division at Redstone Arsenal, told the committee that he had tried to get approval for direct procurement of the *Nike* launcher-loaders from the manufacturer, Consolidated Western Steel Co. However, he said, he was advised that such action would result in Western Electric's denying responsibility for the operation of the launchers in the system.

Other Army officials testified that they did not receive the specifications and drawings for production components until procurement was almost completed. Therefore, breakouts for parts of the system were rare, Army officials said.

• **Changes impending** — Although Sen. McClellan has refused to speculate about legislation that might arise from the hearings, it is obvious that some steps will be taken to reduce the amount of profit on subcontracted work.

A likely step, and one suggested by subcommittee counsel Jerome S. Alderman as a possible solution, would be a maximum management fee for subcontracted work. This fee might run as high as 13% on out-of-house work.

Another possibility is a change in the procurement regulations instructing contracting officers to take into greater account the amount of work to be subcontracted in determining fees. This criterion, along with six others, is already a part of the regulations, but may be upgraded as a result of the hearings.

These and other suggestions are presently under study by the Department of Defense. Meanwhile, the committee is continuing its hearings and expects to hear *Atlas* and *Bomarc* contractors after the Easter recess. ⌗

when and where

APRIL

International Symposium on Rocket and Satellite Meteorology, sponsored by World Meteorological Organization, International Union of Geodesy and Geophysics and Committee on Space Research, Department of Interior Auditorium, Washington, D.C., April 23-25.

American Physical Society, American Institute of Physics, Sheraton-Park Hotel, Washington, D.C., April 23-26.

Materials Handling Conference, American Institute of Electrical Engineers, Pick-Carter Hotel, Cleveland, April 24-25.

Electromagnetic Relay Conference, Oklahoma State University, Stillwater, April 24-26.

American Institute of Electrical Engineers, Great Lakes District Meeting, Hotel Van Orman, Fort Wayne, Ind., April 25-27.

Western Space Age Industries and Engineering Exposition and Conferences, Cow Palace, San Francisco, April 25-29.

International Symposium on the Use of Artificial Satellites for Geodesy, sponsored by International Association of Geodesy and Committee on Space Research, U.S. Naval Observatory, Washington, D.C., April 26-28.

American Society of International Law, "International Aviation Policy", Federal Room, Statler Hilton, Washington, D.C., April 27.

Design Engineering Conference, Ideas from Research Laboratories, McCormick Place, Lakefront Exposition Center, Chicago, April 30-May 3.

Electrical Engineering—Master and Servant of Technological Progress, Chase Hotel, St. Louis, April 30-May 2.

Third International Space Science Symposium and COSPAR Plenary Meeting, National Academy of Sciences, Washington, D.C., April 30-May 9.

MAY

Society of Aerospace Material and Process Engineers Symposium, Statler Hotel, St. Louis, May 7-9.

National Conference of SPSE, Hotel Somerset, Boston, May 7-11.

Second National Conference on Peaceful Uses of Space, sponsored by NASA, Open House, Seattle World's Fair, May 8-10.

American Institute of Electrical Engineers, Statler Hilton Hotel, Boston, May 9-11.

Previews of Progress, Empire Tri-District Meeting, Lawrence Hotel, Erie, Pa., May 14-16.

Eighth National Aero-Space Instrumentation Symposium, Marriott Twin Bridges Motor Hotel, Washington, D.C., May 21-23.

National Telemetering Conference, Sheraton-Park Hotel, Washington, D.C., May 23-25.

American Association for Contamination Control, Jack Tar Hotel, San Francisco, May 28-30.

JUNE

Society of Automotive Engineers, Chalfonte-Haddon Hall, Atlantic City, N.J., June 11-15.

Principles of Nondestructive Testing, Sacramento State College, Sacramento, Calif., June 11-12.

National Society of Professional Engineers, French Lick Sheraton Hotel, French Lick, Ind., June 13-16.

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The Gleeful Conspiracy

ONE OF THE most nationally significant space developments in recent months has received relatively little public attention.

Yet even in its embryonic stage it holds great promise for the security of the nation.

We are referring, not to a new weapon, but to the growing cooperation—both in spirit and deed—between the National Aeronautics and Space Administration and the U.S. Air Force.

Frequent discussions, on this page and elsewhere, of the military and civilian space roles as distinct and individual programs give rise to a separatism which appears greater than it actually is.

Justification for these discussions is the fact that while a major civilian space program exists, a major military space program does not. These states of existence and non-existence create the impression of two quite different entities, if we may be permitted a bit of Socratic dialogue.

As an adequate military space program emerges, we predict it will be found to possess much in common with the civilian program.

Clear thinkers at the top levels of both the Air Force and NASA already are well aware of this. They also are aware of several other important facts.

There are some top NASA officials, possessed of a vision broader than the confines of their own agency, who are acutely aware of the need for major manned and unmanned military space programs. Their knowledgeable grasp of the potentialities of space has made them sharply sensitive to this need.

These men are equally aware that military space programs—particularly for manned spacecraft—are not being funded at a sufficiently high level. To bring these military capabilities to fruition at the earliest possible moment, they are aiding and abetting the movement to bring the Air Force, to a certain degree, under NASA's strong financial shelter in the *Apollo* program.

Here, with technologies which have much in common, the Air Force will be able to learn and progress by participating in activities funded in the NASA budget.

Equally astute Air Force officers have been quick to see the advantage of this cooperation. Military scientists and technicians at work on the *Satellite Inspector* program will find much to discuss with NASA personnel engaged in design and development of the *Gemini* spacecraft. This is but one area of common interest.

Such cooperation will be of great benefit to the nation because it will enable the Air Force to get off the mark quickly in developing its space capabilities. This is no one-way street. The military service has much to offer to NASA in facilities, knowledge and personnel.

The natural trend of events might have brought such collaboration into being eventually. But a small and active group of Air Force and NASA leaders has been impatient with this evolutionary pace. They have been force-feeding the cooperative movement in an almost gleeful conspiracy.

Out of this movement has come, as one major development, the establishment of an office for manned space flight in the Air Force Systems Command.

This office, under a deputy AFSC commander, works in liaison with the manned space flight office at NASA. It was set up with the announced objective of giving the Air Force a larger role in the manned lunar landing program—not as a manager, but as a major contributor.

The far-sighted group working to develop and strengthen NASA-Air Force cooperation includes such men as General Bernard Schriever, AFSC commander, and Dr. Robert C. Seamans and D. Brainerd Holmes of NASA.

The spirit growing out of their efforts has become an almost tangible thing in recent weeks.

"Have you noticed the difference?" asks a high NASA official. "A positive and valuable development in the national space program," comments an Air Force officer.

IT WOULD have been easy—would, in fact, have required only inaction—to have allowed the two agencies to go their separate ways to the detriment of the national space program. The group concerned has made a positive effort to prevent this, and we hope the leadership displayed will be publicly recognized.

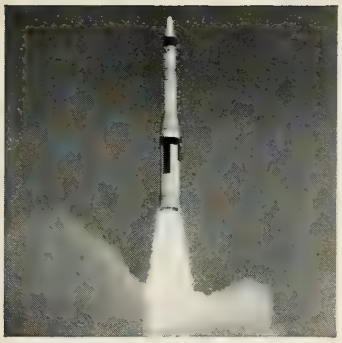
We hope also it will be noted in lower levels of both organizations.

This is not to suggest that everything henceforth will be sweetness and light between NASA and the Air Force. Already, there are areas of contention bordering on bitter disagreement. Cape Canaveral shows signs of being one such trouble spot.

But this is not wholly bad. The beginning of cooperation does not have to mean the end of competition. In fact, NASA Administrator James Webb told us shortly after taking office that he regarded a little healthy competition at the right levels as a good thing.

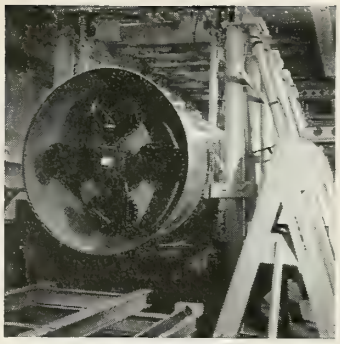
This competition will no doubt continue. It will be an intelligent kind of competition, however, nourished by a prevailing climate of partnership. For this, everyone concerned with our space accomplishments should be grateful.

William J. Coughlin

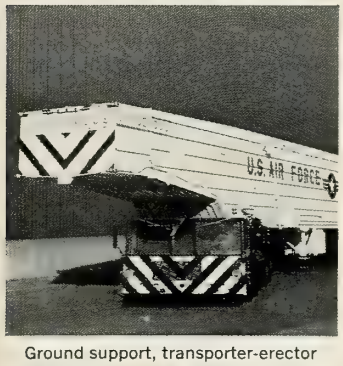


Minuteman test flight

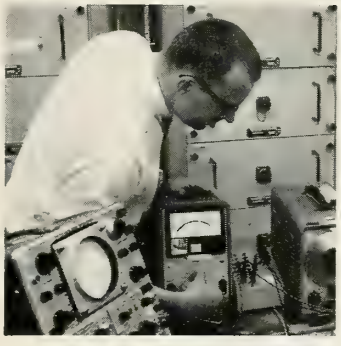
Missile assembly



Dynamics test



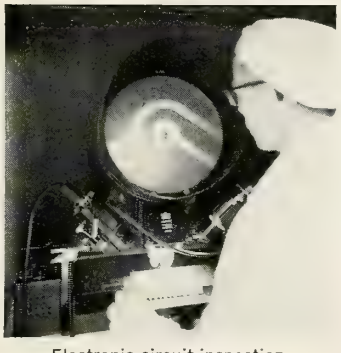
Ground support, transporter-erector



Minuteman electronics assembly

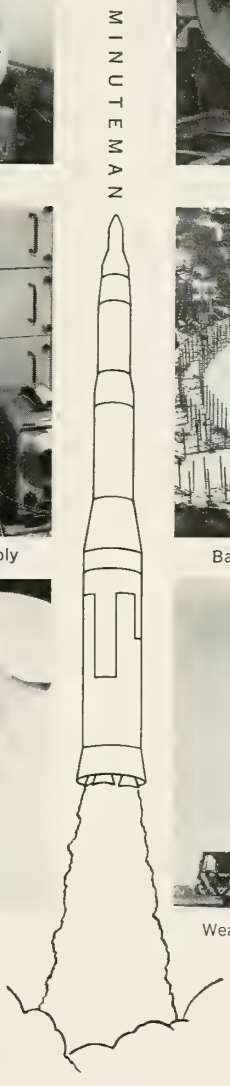
Base-Construction Surveillance

Management techniques: PERT



Electronic circuit inspection

Weapon system assembly at sites



Minuteman system integration—by Boeing Aero-Space Division

From electronics to the latest business systems and techniques, Boeing's Aero-Space Division employs a wide range of capabilities as Minuteman weapon system integrator.

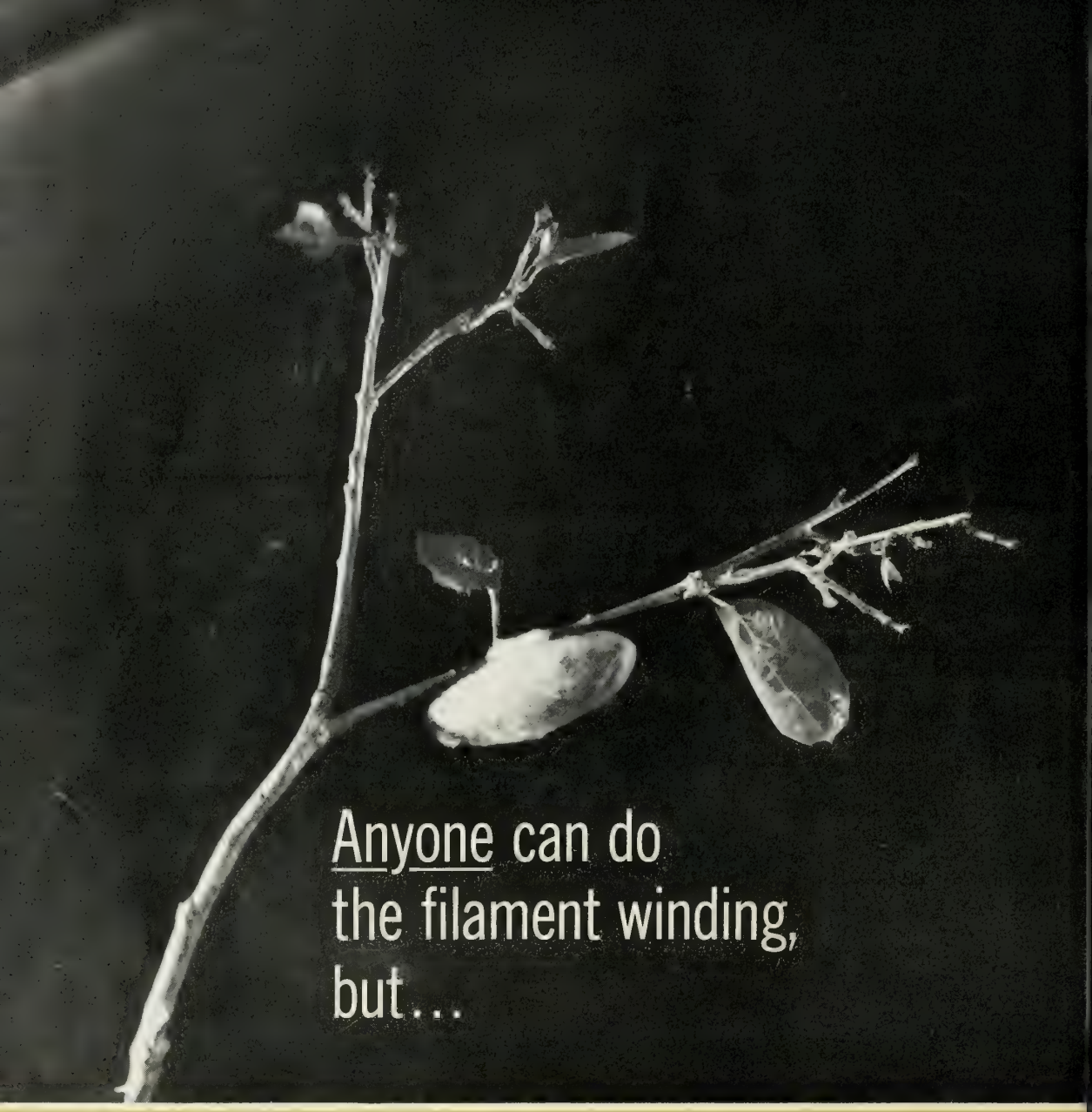
The Division is responsible for Minuteman missile assembly, test, launch control and ground support. Working with the Air Force Systems Division, Aero-Space coordinates the work of associated contractors and exercises surveillance over base construction. It also assembles at base sites the final weapon system, including support and launch systems. Prominent among the latter are Boeing-designed and built electronic systems.

The Division has more than 4,000 employees wholly engaged in electronics engineering, manufacturing or in the support of these activities.

Minuteman has been described as "an economical breakthrough" in terms of procurement and maintenance costs. This Strategic Air Command weapon system will be operational late this year, a year ahead of original schedule.

BOEING

AERO-SPACE DIVISION



...IN ROCKET TECHNOLOGY, THE SECRET IS TO DEVELOP A METHOD OF [redacted] OR SECURING TOGETHER LARGE FIBERGLASS CASING SEGMENTS TO PRODUCE HUGE BOOSTERS WITH MULTI-MEGAPOUND THRUSTS THAT CAN BE EASILY TRANSPORTED AND ASSEMBLED IN THE FIELD. UTC HAS DONE THIS. A METAL MECHANICAL JOINT PROVED HIGHLY SUCCESSFUL IN A TEST-FIRING OF THE FIRST SEGMENTED, SOLID PROPELLANT ROCKET MOTOR EMPLOYING A FIBERGLASS CASING. THE INHERENT ADVANTAGES OF EPOXY-BONDED FIBERGLASS CASINGS FOR LARGE BOOSTERS ARE SIGNIFICANT: ☐ LOW PRODUCTION COST AND REDUCED PRODUCTION LEAD TIME, BECAUSE DIFFICULT METAL CASING FABRICATION IS NOT REQUIRED. ☐ LIGHT WEIGHT, ANOTHER IMPROVEMENT OVER METAL CASINGS. ☐ HIGH STRENGTH-TO-WEIGHT RATIO. ☐ ON-SITE ASSEMBLY OF FIBERGLASS ROCKET MOTORS. ☐ IMMEDIATE DEVELOPMENT OF FIBERGLASS CASING SEGMENTS FOR ROCKET MOTORS 120″ IN DIAMETER AND LARGER. RELATED UTC CAPABILITIES INCLUDE FILAMENT-WOUND ABLATIVE-COOLED THRUST CHAMBERS, ROCKET MOTOR CASINGS IN ALL SIZES, NOZZLES. ANOTHER ADVANCE IN THE STATE-OF-THE-ART BY UTC.

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APRIL 30, 1962

missiles and rockets

THE WEEKLY OF SPACE SYSTEMS ENGINEERING

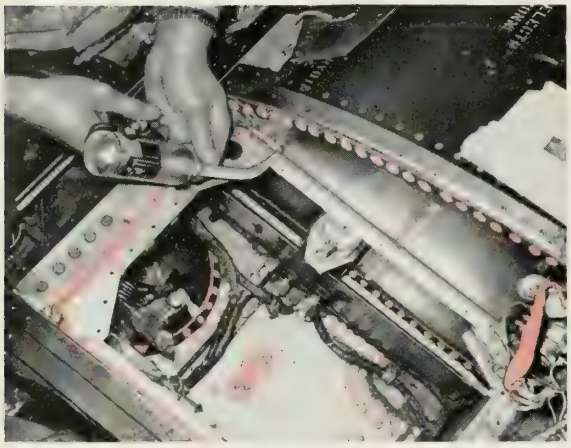
Assembling Prototype ANNA Satellite

East-West Cooperation Talks Intensify . .

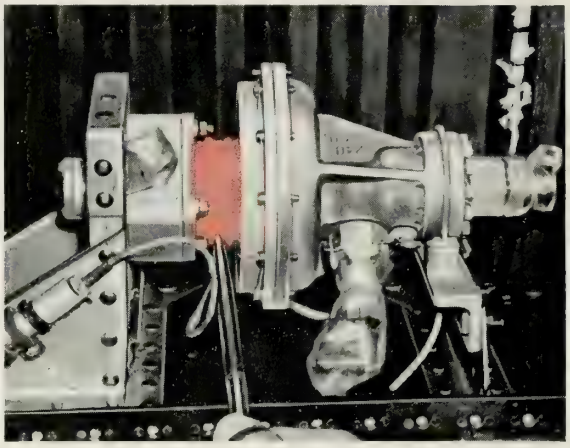
S-4 Static Firing Next Test for Saturn . . .

How Boeing Won Big Saturn Award . . .

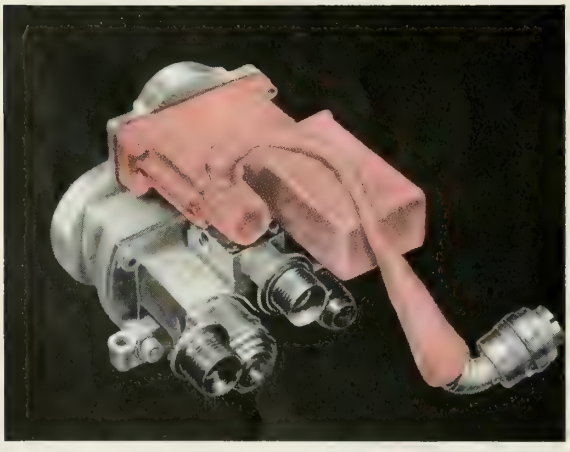
GENERAL ELECTRIC RTV SILICONE RUBBER KEEPS THE PRESSURE IN THE X-15!



Critical pressurized areas of the X-15, designed and built by North American Aviation through a joint NASA-Air Force-Navy research project, are sealed with General Electric RTV (room temperature vulcanizing) silicone rubber. After a thorough analysis of all high temperature sealants, RTV was selected to seal the aft bulkhead behind the cockpit, instrumentation compartment and shelving near the ship's mid-section.



RTV adhesive seals heating blanket for helium pressure regulator. RTV rubber forms tenacious bonds to most materials provided surfaces are properly primed. It is easily removed from unprimed surfaces. It can be applied by dipping, pouring, spraying or buttering—cures in place at room temperature to form a tough, flexible seal. Cure times can be varied from minutes to hours depending on catalyst used and heat, if applied.



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TYPICAL PROPERTIES OF RTV SILICONE RUBBER

	RTV-11	RTV-20	RTV-40	RTV-60	RTV-77	RTV-88	RTV-90
Viscosity, Poises	120	300	450	550	8,000	10,000	12,000
Color	White	Pink	White	Red	White	Red	Red
Consistency	Easily Pourable	Pourable			Spreadable Thixotropic Paste		Stiff Paste
Temperature Resistance	FROM −90°F TO +600°F FOR EXTENDED PERIODS TO 9,000°F FOR LIMITED TIME AS THERMAL INSULATION						
Specific Gravity	1.18	1.35	1.37	1.47	1.33	1.47	1.47
Radiation Resistance	10^8 ergs/gram						
Tensile Strength, psi	350	450	550	650	500	750	750
Shrinkage, %	0.4	0.2	0.2	0.2	0.3	0.3	0.2
Durometer, Shore A	45	50	55	60	50	65	60
Volume Resistivity, ohm-cm	6×10^{14}	5×10^{15}	1×10^{16}	2×10^{15}	1×10^{15}	1×10^{16}	2×10^{16}
Solids Content, %	100	100	100	100	100	100	100
Elongation, %	180	140	120	110	220	110	190

A wide range of RTV compounds meet a variety of application requirements. Low viscosity RTV-11 (or transparent LTV-602) is used for potting electronic assemblies and coil impregnation. RTV-77, 88 and 90 are mainly used for high-temperature sealing and for thermal insulating and ablative applications. Intermediate viscosities meet other insulating and sealing requirements, are also used as flexible mold materials.

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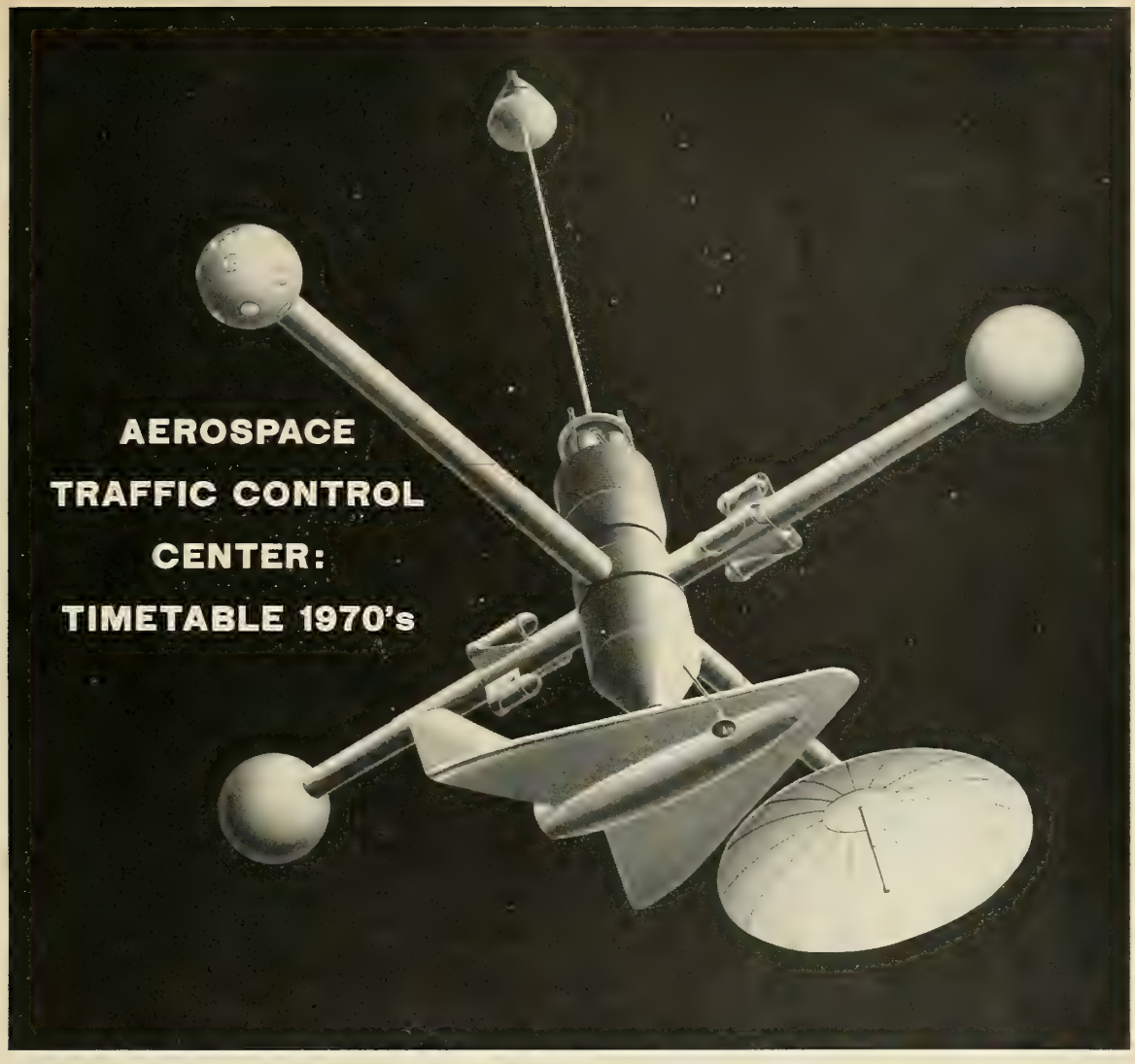

A typical example of advanced design by Lockheed-California Spacecraft

Will command centers based in space be an outstanding development in the ten-year span from 1967 to 1977?

The answer at Lockheed-California Company's Spacecraft Organization is—Yes. Proof: the Spacecraft design pictured here. It reflects the maturity developed in our thinking about manned space systems.

The station—aeroscope traffic control center of the 1970's—will be assembled in orbit in a series of pieces brought together by rendezvous techniques. Included: Command center; living quarters; maintenance station; radar and infrared sensing devices; nuclear power supply; communication links with the earth and other space vehicles. As now planned, 12 people will man the vehicle. Their tour of duty will be measured in weeks.

For four years Lockheed-California Spacecraft has concentrated on the needs of man in space. Activities embrace all fields pertaining to development of complex spacecraft as well as supporting technologies. An operation of such magnitude opens many doors of opportunity.

Scientists and Engineers of outstanding talent and training are needed to develop new Spacecraft, Aircraft, ASW concepts in: Human Factors; Physics (theoretical, plasma, high-energy, solid state, infrared, optics, nuclear); Thermodynamics; Servosystems; Reliability; Guidance and Control; Dynamics; Electronic Systems; Aerospace Ground Equipment; Bioastronautics; Systems Integration and Trade-Off; Space Mechanics; Sub-Systems Synthesis and Analysis; Nuclear, Electric and Liquid Rocket Propulsion; Electronics Research; Hydrodynamics. Send résumé to: Mr. E. W. Des Lauriers, Manager Professional Placement Staff, Dept. 1704, 2404 N. Hollywood Way, Burbank, California. An equal opportunity employer.

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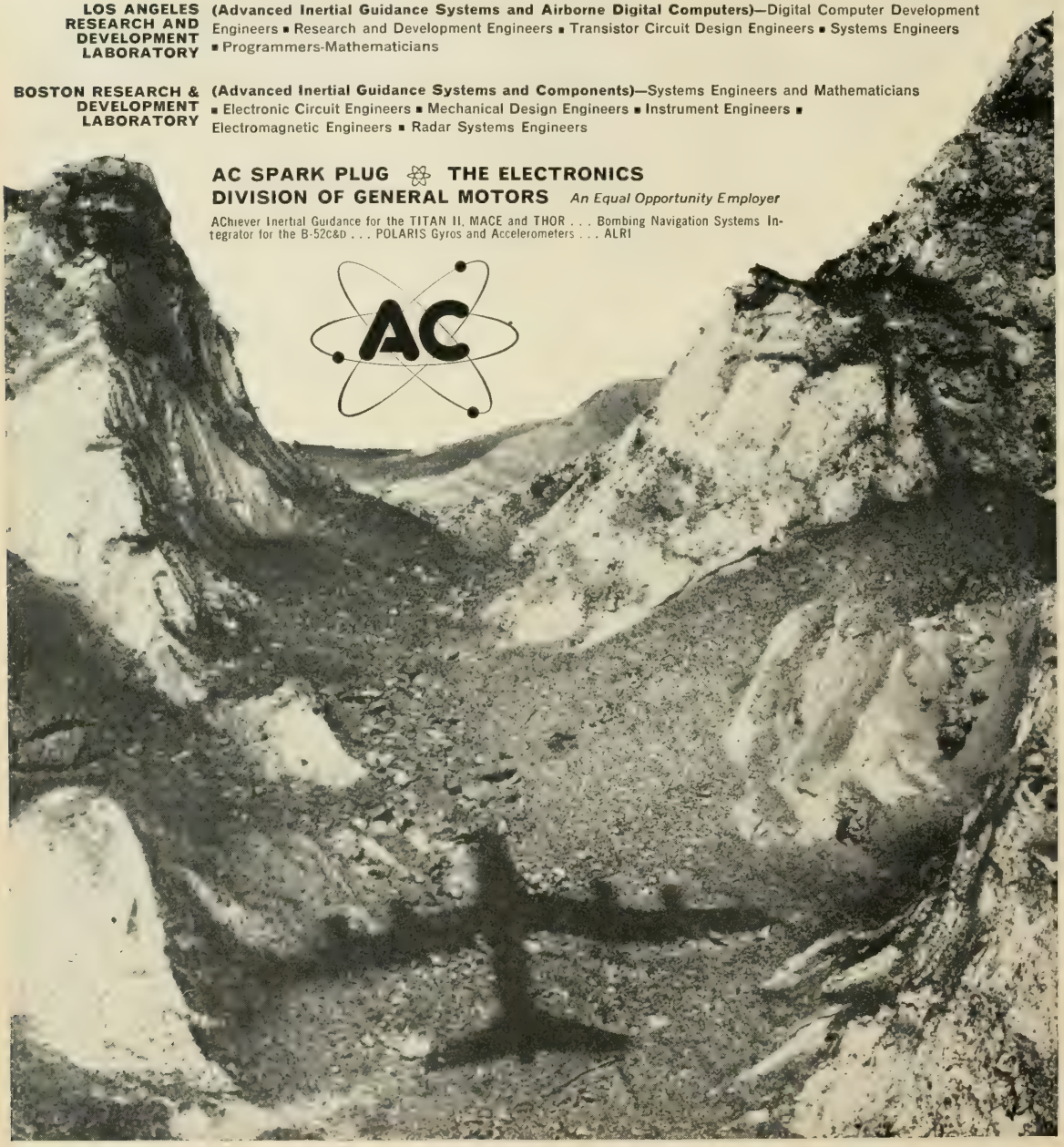

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missiles and rockets

Volume 10, Number 18 April 30, 1962

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THE COVER

ANNA geodetic satellite prototype has its xenon flashtube installed at Edgerton, Germeshausen & Grier, Inc. ANNA will help determine distances on Earth by optical tracking of its flashing light. See p. 11.

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letters

Civil Service Scales

To the Editor:

Many of your editorials I read with gusto, because they are usually composed of a healthy regard for the impact of current events and a basic explanation of facts. However, in your April 16 editorial ("Those Lush Defense Profits"), you indulged in a tactic to which all industrial writers eventually succumb. That is, using the civil servant or his pay scale as a whipping boy.

Although it may have been true that the Army, at the inception of its *Nike-Zeus* program, probably did not have a sufficient amount of personnel with the necessary technical management skill to support the elimination of industrial "middlemen," it seems to me that several industries were lacking such personnel also. With the above subject properly equated, may I further point out that your point, "Civil Service pay scales would have precluded hiring qualified systems management engineers," is neither pertinent nor necessarily true.

Being a rather sensitive, but poor, civil service worker, I do not have to be reminded of the relatively low pay scales. But I certainly do not feel any less qualified because of my loyalty to the civil service system.

Indeed, sir, I can think of at least two reasons why industry must have highly paid "middlemen"—neither of which involves a "begging the question" form of critique of civil service.

I would appreciate your editorials much more in the future knowing that I would not be distracted by impertinent techniques.

Joseph L. Townsend
G. M. Specialist
Ordnance Supply Analysis Agency
Raritan Arsenal
Metuchen, N. J.

Categories and Verse

To the Editor:

I would like to comment on two letters in M/R, April 16. In one, Mr. Paul J. Malie wonders whether or not Col. Glenn ought to be three days "younger" because he traveled from West to East and (it would seem) somehow "unwound" a few days. Actually, as he went in the same direction of motion as the Earth, he would, if anything, have become "older." To prevent such confusion, the Earth was divided many years ago into time zones, and the International Date Line was established. Every 15 degrees of longitude of travel would give an orbiting astronaut an extra hour, but crossing the date line would even the score. When he returned over his point of origin, the times on the ground and above it in the spaceship would again be equal. Even to the day.

In a more serious note, I would like to comment on Mr. T. J. Nawrocki's letter entitled "Who's An Engineer?" His is a good point, but it is a sword that cuts both ways. My own case is an example.

I am a graduate of a rather well-known college, but my degree is in philosophy. Therefore, when looking for employment, I tried to get a job as a technical writer rather than an engineering job. Having had several things published, both fiction and articles, I felt (and still feel) well qualified for such a job.

I applied to a large concern in the missile/space field and, after forwarding copies of my application and photocopies of my technical article, I was granted a couple of interviews. In one of these—possibly because of a semitechnical article I wrote on speaker systems—I was told of a job as an "associate engineer" in the quality control division, if I could handle it.

I knew I could not, and could not follow up this opening.

However: When I applied, I did not once mention the possibility of seeking an engineering job. This was somebody else's idea. At the time it was suggested all parties concerned knew of my educational major.

So who is at fault here? I would venture to say that there is fault on both sides of the fence. I would further go as far as to suggest that perhaps there ought to be some industry-wide agreement on exactly what terms define what, and that these should be standardized. It might even be a good idea to develop a term to classify those with a certain amount of engineering skill, but not enough to rate an "engineer" classification, as something else—technicist, for example. If we had a National Aerospace Classification Table things would be simpler. If a company wanted to give someone a classification (such as "associate engineer") which did not conform to his actual job, his employment record could read something like: NULLSPACE CO. EMPLOYMENT RECORD. DOAKES, Joe (NMI)—Associate Engineer (Technicist NACT) . . . and everybody would be happy, including the personnel people who are by now probably up to their ears in confusion.

Stephen A. Kallis, Jr.
Dunedin, Fla.

To the Editor:

Thank you for your poem, "The Lights of Perth—I," in M/R, April 16. I can't read your magazine—it is all, way over my head. But sometimes I do idly turn the pages, and I am so glad that I did this time.

Mrs. R. E. Arentson
Orlando, Fla.

The J. P. Davis who wrote the poem is Miss J. P. Davis, a nuclear engineer with Burns & Roe, Inc. "The Lights of Perth—II" appeared in the April 23 M/R. We hope to publish more of Miss Davis' work in forthcoming issues.—Ed.

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Clues to Cosmoses

To the Editor:

While perusing a number of articles that I have collected over the past several years concerning Soviet astronautics, I chanced upon two reports that appear to give clues as to the origins and uses of Earth satellites *Cosmos I* and *Cosmos II*, launched March 16 and April 6 respectively.

In M/R, Feb. 15, 1960 (pp. 25 & 29), a town called Kapustin Iar (the National Geographic Society map of the USSR calls is Kapustin Yar) is given as a satellite launching site. M/R lists the coordinates as 48°27′ North, 45°35′ East—about 60 miles east-southeast of Stalingrad (now Volgograd). It also reports that satellites launched from Kasputin Iar may be launched to the east over the Caspian Sea.

It is a well-known law in orbital mechanics that if a satellite is launched directly to the east from a given latitude, the inclination of the satellite orbital plane to the plane of the equator is equal in value to the latitude of the launch site. Any Earth oblateness effect would be second-order or smaller in this relationship. Press reports are that the inclination of the orbital planes of both *Cosmos I* and *Cosmos II* is 49°. Latitude given in M/R is 48°27′. It appears that the USSR has initiated a new launch site at Kapustin Iar, since they previously claimed that their space launchings took place at Baikonur—hundreds of miles east of Kapustin Iar. To strengthen this belief, a TASS report on page 1 of *Pravda* for March 17 says ". . . a series of artifical satellite launchings will be conducted in 1962 *from different cosmodromes* of the Soviet Union."

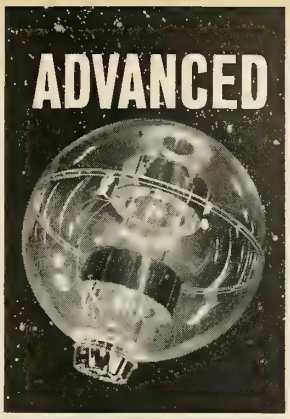
In the April 24 issue of *Aviation Week* is a report of a discussion on space biology and medicine by Soviet scientists Ivan Maisky, Valdimir Englehardt and Andrei Lebedinsky. It makes the following points:

1. The next major goal of Russian space research will include determining the extreme limits of survival of living organisms in order to make prolonged flight . . . as safe as Earth-orbital flights.

In penetrating further into the radiation zones, new protective measures will have to be devised.

The writer believes that *Cosmos I* and *II* are being used to evaluate points 1 and 2 above, and for other tasks—vis., cloud-cover studies as announced by the USSR. Further, one might hazard the guess that this phase of research was commenced only recently, in order that previously obtained data could be reduced and thoroughly evaluated in preparation for the present tests. Finally, since the apogee of *Cosmos I* was initially about 600 statute miles, and that of *Cosmos II* initially about 960 statute miles, one may indeed assume that separate zones of the radiation belts are being examined.

Saunders B. Kramer
Senior Member, American Astronautical Society; Fellow, British Interplanetary Society
Sunnyvale, Calif.



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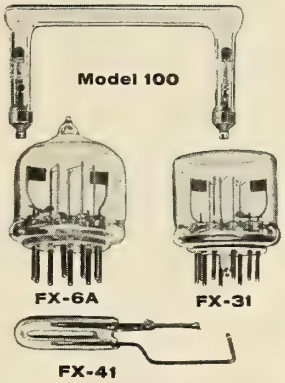

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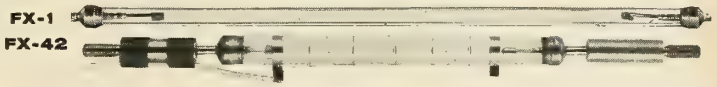

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NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

The Countdown

WASHINGTON

Ranger 5 Last Chance in '62

NASA will get one more opportunity to successfully complete a *Ranger* spacecraft mission this year. A *Ranger 5* shot is scheduled for early in the last quarter. The long delay between *Rangers 4* and *5* is required because of the two *Mariner* launches slated during the late July-early September period. These will use the same *Atlas-Agena* pad employed at the Cape for *Ranger*.

Another 'Hold' on 120-in. Solid?

It now appears that the contract award for the 120-in. solid booster for the *Titan III* space booster is being held back for yet another study. This time, however, it is reported that the new look is aimed not at feasibility but at the contractor structure and program management.

Navy Plans Satellite Launching Ships

The Navy is developing ships—most likely refitted Victory ships—for launching satellites into orbit around the equator or at a specific latitude or longitude. Noting that in the past electronic equipment was too sensitive to withstand heavy seas, the Navy now contends that "almost anything electronic" can operate in a State 5 sea.

Projects Madre and Tepee Very Much Alive

Although very little concerning them has been disclosed in the past year, Projects *Madre* (Navy-AF program to develop a high-power, long-range, over-the-horizon radar) and *Tepee* (investigations to detect ballistic missile launchings over long distances), programs apparently have been highly successful. The Navy reports that preliminary experiments "using the two-hop technique have been successful, with ranges achieved on the order of 4000 miles."

DOD Warns Against Research Costs Rider

In testimony released before House passage of the defense appropriations bill, DOD officials argued against inclusion of the maximum 15% ceiling on indirect research costs for universities. They asserted that the effect of the ceiling would be to drastically curtail university research activity, constituting "a serious impediment" to defense research.

Defender Research Expanded

ARPA is expanding its ballistic missile phenomenology research program to include "a significant number of satellite-borne measurements" of ICBM's during their launch phase. Conducted under the title TABSTONE, the program has existed since spring of 1961; until now, however, measurements have been restricted to aircraft and rocket probes.

Mauler Development Speeded

Funds in the Army's FY '63 RDT&E budget will accelerate development of the *Mauler* air defense weapon system. The Army, gratified with the system's progress so far, expects to complete most of the R&D during FY '63 so that it can get the badly needed weapon into the field as soon as possible.

INDUSTRY

Aerojet Gets Go-Ahead for Solid Tests

With announcement of the *Titan III* 120-in. solid booster contract still pending (see second item above), Aerojet-General announced it had been given AF permission to report that it will test-fire nine "very large" solid motors during the next 2½ months. The firings will be under a previously announced $4-million contract for testing advanced methods of steering solid rockets and advanced ignition systems. Under the program, Aerojet recently fired for 100 sec. a 600,000-lb.-thrust, 119-ton segmented motor—largest ever fired in the U.S.

H-1's Moving to Missouri

North American Aviation is moving production of its H-1 engines for *Saturn* from Canoga Park, Calif., to Neosho, Mo. The Rocketdyne division expects to produce the first test engines there this spring, and production models early in the fall.

Gerrity Lauds Overall ICBM Progress

The entire U.S. ICBM program is "very close" to original cost estimates—and actually ahead of the first development and deployment schedules, according to Maj. Gen. Thomas P. Gerrity, commander of the AF Ballistic Systems Division. In a New York speech last week, Gerrity noted that concurrent methods of base activation, missile R&D, crew training, and flight-testing had made the Convair *Atlas* operational in 5.2 years from time of program approval, Martin's *Titan I* in 5.8 years. He said the spread for the Boeing *Minuteman* would be less than four years.

INTERNATIONAL

British Buy Bundle of AS-30's

The RAF has ordered 1000 French *AS-30* air-to-ground missiles for an estimated price of $14 million. It's the first foreign purchase of the Nord-Aviation weapon. Meanwhile, the Royal Navy is negotiating with Nord for a purchase of wire-guided *SS-11* antitank missiles—already in use with French, German and U.S. forces.

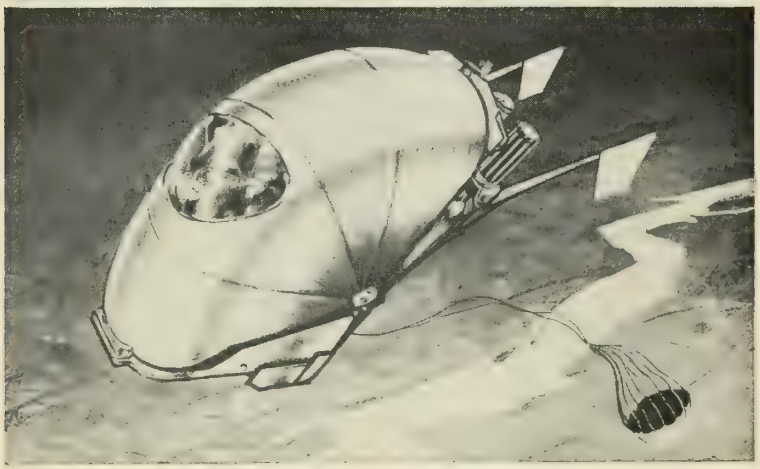
Japan Near Choice on Defense System Award

The Japanese government has narrowed competition for an air defense system for its Air Self-Defense Force to three U.S. firms—General Electric, Hughes Aircraft Co. and Litton Industries. The command and control system will direct aircraft and missile interceptors.

Help for Astronauts in 'The Tower'?

Officials at the Tower of London have sent AiResearch Manufacturing Company details of a suit of armor designed for Henry VIII. It may be of help in developing future spacesuits. The gimmick is that the regal suit in question was built for fighting on foot at tournaments; unlike most suits of armor, designed primarily for mounted combat, it completely enclosed the body, leaving no gaps. AiResearch wrote to the Tower after it was unable to get similar assistance from New York's Metropolitan Museum.

Hydro-Space News



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The Missile/Space

Shots of the Week

Second successful launch of the *Saturn* booster took place April 25, followed by a spectacular experiment which released 95 tons of water at 65 miles altitude. The 162-ft. booster, developing 1.3 million lbs. thrust, impacted several hundred miles down the Atlantic Missile Range from Cape Canaveral. The two upper stages, containing water ballast, were intentionally blown up to create the ice cloud, described as the highest in history. (See p. 14.)

• *Ranger IV,* after near-perfect launch and guidance phases, failed to transmit any significant scientific data on its trip to the moon, due to malfunction of a timer. Launched April 23 from Cape Canaveral, the 730-lb. payload failed to perform operational functions controlled by the on-board electronic computer. *Ranger V* is expected to be launched before year's end. (See p. 14.)

• Primary test objectives in the *Skybolt* program—in-flight launch and ignition—were met in the air-launched ballistic missile's initial firing April 19 from a B-52 jet bomber over the Atlantic Missile Range. The test fell short of the planned 900-mile flight, reportedly because the second stage failed to receive a firing command. Air Force officials were nevertheless pleased with results. (See p. 18.)

• Automatic in-flight destruction of a *Nike-Zeus* antimissile missile was carried out April 19 off Point Mugu, Calif. before the vehicle could intercept a phantom target. Ignition of both stages was successful before the premature termination, but technical difficulties developed in the second stage.

• *Minuteman,* ending a seven-shot success streak, was destroyed by the Canaveral range safety officer after a night silo launch April 24.

• A similar fate befell *Pershing,* which, after 13 successes, went off course at the Cape and was destroyed April 24. It made *Pershing's* record 28 successes in 32 attempts over the entire program.

• Two *X-15* flights were racked up at Edwards AFB during the week, one by Joe Walker on April 19 and another by Neil Armstrong on the 20th. Walker went to 150,000 ft. and 4000 mph in a test of a secondary emergency control system, and Armstrong soared to 207,000 ft. and 3818 mph to test the automatic pitch, yaw

and roll control system. NASA expects to run the *X-15* through its maximum paces of 255,000 ft. and 3785 mph sometime this week. AF pilot Capt. Robert White has already reached the design speed of 4093 mph.

• *Cosmos III,* third in a new series of Soviet satellites described as payloads to measure the Earth's radiation belts, cloud patterns, and other scientific phenomena, was put in orbit April 24. Few data were released concerning the size or weight of the package, whose orbit is inclined 49 degrees with an apogee of 447 miles, perigee 142 miles.

Centaur Nearly Makes It

The fifth attempt in two weeks to launch *Centaur* from Cape Canaveral failed April 21, when booster cutoff occurred just after ignition. NASA announced that a malfunction in the umbilical system, not in the vehicle, caused the shutoff. The *Atlas* first stage, locked to the launch pad, emitted flame and smoke upon ignition. But these died quickly as an automatic system shut down the engines when the umbilical cable failed to release.

Gemini Order to Rocketdyne

A series of small storable-fueled rockets to maneuver the *Gemini* capsule in orbital and rendezvous flights will be supplied by Rocketdyne Division of North American Aviation to McDonnell Aircraft. Two engine sizes will be used. One system will handle docking operations and a second will be used to position the capsule for re-entry.

Updating Newton's Laws

A research scientist suggested in a paper presented to the American Physical Society in Washington, D.C. last week that Newton's laws of motion be updated in the light of modern experience.

He theorizes that all real bodies —including even the smallest subnuclear particles—have built-in delay times in responding to a force, depending on how it is applied.

In effect, Dr. William O. Davis—Huyck Corp.'s Director of Research, and former Chief of Scientific Research and Development Command —hypothesizes the need to include a term for the rate-of-change-of-acceleration in the equation of motion.

As a consequence of the modified equation, Dr. Davis suggests two additions to the classical laws of motion:

1) The observed momentum of a real body cannot be changed instantaneously regardless of the magnitude of the applied force.

2) Action and reaction in a system of real bodies cannot be exactly simultaneous.

Live Polaris To Be Tested

A "live" *Polaris* missile and warhead will be tested during the U.S. nuclear test series which began in the Pacific last week, according to an unconfirmed report.

The test will be the first of a complete missile system ever conducted. Warheads for all of the other missiles in the U.S. arsenal not previously tested will also undergo proof tests, but not as complete systems integrated with their delivery systems.

ANNA Secrecy Reportedly Lifted

The security curtain which has blacked out discussion of *ANNA*—a joint geodetic satellite project for more accurate mapping of distances on the Earth—has reportedly been lifted.

According to the report, which could not be verified before M/R went to press, Deputy Defense Secretary Roswell L. Gilpatric took the action after an intensive review of the program.

Titov to Visit U.S.

Russian Cosmonaut Gherman S. Titov has applied for a visa to visit the U.S. from April 30-May 7 as a Soviet delegate to the third annual International Space Conference to be held in Washington this week.

Titov will present a paper to a bioastronautics panel of the conference—as will U.S. Astronaut Lt. Col. John H. Glenn, Jr.

Welsh Receives Award

Dr. Edward C. Welsh, Executive Secretary of the National Aeronautics and Space Council, was awarded the Arnold Air Society trophy as the civilian of 1961 who made the most outstanding contribution to aerospace science and national security.

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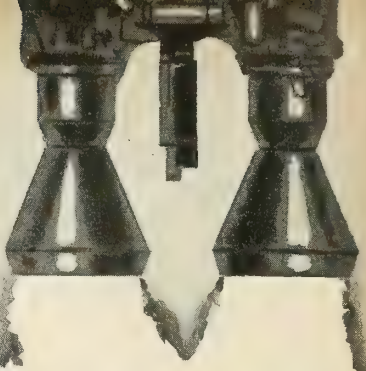

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Limited pact sought . . .

U.S./Russia—Critical Stage in

American officials guardedly optimistic; scientists on both sides agree to formation of joint 'Weather Watch'

U.S.-USSR efforts to cooperate in space are reaching the critical stage, but top American officials continue to express guarded optimism over the chances for a limited agreement.

"I am encouraged to believe that they want limited cooperation," Dr. Hugh Dryden, top U.S. negotiator, told MISSILES AND ROCKETS.

The same view was taken by Dr. Edward C. Welsh, executive secretary of the National Space Council, the White House's space advisory group.

"The preliminary meetings at the UN made headway in creating a cooperative atmosphere. Up to this point, we have felt encouraged," said Welsh.

Both officials commented following the disclosure that U.S. and Russian scientists in the World Meteorological Organization had agreed to set up a joint Weather Watch involving meteorological satellites.

Dryden noted that this was not a bilateral agreement between the two countries. He said formal agreements with the Soviets on space will hinge on future negotiations.

Whether these negotiations will ever take place is a moot point. When the preliminary UN talks between Dryden and the Soviet Representative, Dr. Anatoli A. Blagonravov, were completed, it was indicated future negotiations might take place at the COSPAR meeting in Washington and the meeting of the UN subcommittee on Outer Space in Geneva.

• **U.S. is willing** — The COSPAR meeting begins on April 30, but the Russians still have not communicated any willingness to get down to hard bargaining.

"We are ready to talk about limited cooperation anytime Russia is," Dryden said.

"By limited cooperation," he continued, "I mean those areas covered in President Kennedy's letter to Premier Khrushchev."

He added that this does not include launch sites or rockets. An agreement in those areas is a long time in the future, the NASA official said.

He also declared that cooperation in space must be mutually beneficial, indicating that the U.S. does not intend to foot the total bill for cooperative space efforts.

Besides the lack of a firm date for negotiations, another possible roadblock in the way of joint space efforts is the Soviet reaction to this country's resumption of nuclear testing.

It is quite possible that Khrushchev will use the new nuclear blasts as a pretext for breaking off even preliminary discussions. One high State Department official said he feels this is doubtful. "I believe," he said "that Russia is serious about certain forms of space cooperation and I don't think it is tied to either nuclear testing or disarmament."

Despite their optimism, both Dryden and Welsh agreed that an accord between the two nations is a long way from fruition.

• **First step** — They also agreed, however, that the agreement to cooperate in forming the World Weather Watch by U.S. and Soviet meteorological scientists is a step in the right direction.

This is a grand design for pooling data and resources including space vehicles and data reduction equipment to help chart and predict global weather.

Groundwork for the agreement was laid when the United Nations General Assembly passed a resolution last Dec. 20 calling for using space for peaceful purposes, and subsequently by an exchange of notes between President Kennedy and Premier Khrushchev in which specific areas including meteorology were suggested as common meeting grounds.

This new spirit of cooperation between the U.S. and USSR resulted in talks in Geneva last month between Dr. Harry Wexler, Research Director of the U.S. Department of Commerce Weather Bureau, and Dr. Viktor A. Bugaev, Assistant Director of the USSR Hydrometeorological Service. The two scientists were attending a meeting called by the Secretariat of the World Meteorological Organization (WMO) in response to a UN request stemming from the December UN resolution.

• **A role for all**—Dr. Wexler revealed at a press conference last week that the recommendations of the Geneva WMO group call for worldwide cooperation in weather-data collecting and processing, and in setting up facilities where they are needed. He added that various underdeveloped countries might want to get together to sponsor regional facilities which would also form part of a global network for receiving data from weather satellites.

The next step will be taken on May 29 when the Geneva group sends its final report to the WMO Executive Committee for review. After it is approved, the report will be given to the UN, probably by mid-summer.

• **USSR's new stand**—Up to now, Soviet scientists have been boycotting all WMO meetings concerned with weather satellites. A break in this position was evidenced first at the Geneva meeting and again last week in a Soviet-authored paper presented to the First International Symposium on Rocket and Satellite Meteorology (ISRSM), meeting in Washington, D.C.

Titled "An Investigation of the Stratosphere by Means of Meteorological Rockets in the USSR," the paper was delivered by Dr. Konstantin T. Logvinov, Deputy Director of the USSR Hydrometeorological Service. After his talk, he told newsmen that "Soviet meteorologists will do their best to work with (other meteorologists) on any assignment given to them (by WMO)."

Affirming that he and his colleagues watch U.S. weather satellite experiments with great interest, he said his countrymen were considering contributions to a cooperative effort.

The scientist ruefully observed that

Space Talks

by William Beller

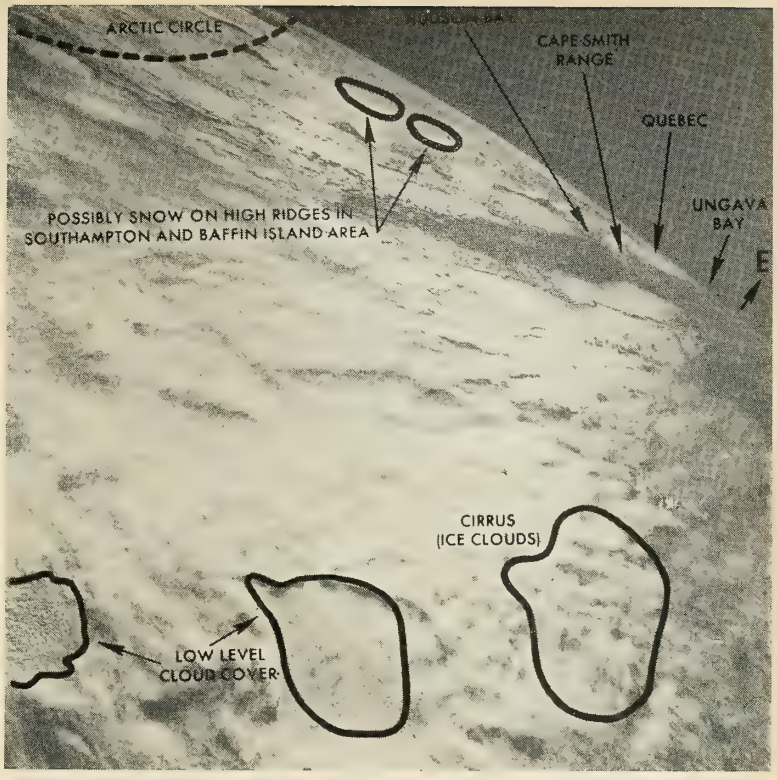


Photo Shows 'Weather Watch' Potential

NEWLY RELEASED photo was taken at 139 miles' altitude from an Aerobee-150 fired from Fort Churchill, Canada, as part of Arctic Meteorology Photo Probe project sponsored by NASA's Goddard Space Flight Center. Infrared film and Wratten 88-A filter were used; camera set at 1/500-sec. at f/8.

although data from *Tiros* weather satellites are studied by Soviet meteorologists, the information from them—furnished routinely by the U.S. Weather Bureau over international radioteletypewriter networks, and since April 15 by radiofacsimile transmission of cloud maps—has only limited practical value because the areas surveyed are mostly far from the Soviet.

Logvinov stated that while the Soviet has no specific meteorological satellite in orbit, some Russian orbiters are equipped with "radiation instruments able to measure various scientific parameters." He added that these satellites do not have cameras for taking pictures of the cloud cover.

Logvinov spoke last Tuesday, a day before TASS announced the successful launching of *Cosmos III*, third in a series of unmanned satellites reportedly sent up to study factors connected with weather, communications, and radiation effects on man.

• **Bases for understanding** — The symposium at which the Soviet scientist spoke was attended by more than 500 participants, representing over 20 nations. The April 23-25 meeting was called to hear papers on progress in meteorological rockets and satellites. It was organized by the World Meteorological Organization, International Union of Geodesy and Geophysics, and the Committee on Space Research (COSPAR) of the International Council of Scientific Unions.

Many of the private and public discussions held during the sessions were looked upon as forming bases for international cooperation in programs for future meteorological vehicles, such as those to be sent up during the International Years of the Quiet Sun, 1964-65. During this period, solar activity is expected to be at a minimum—in contrast to the International Geophysical Year, when such activity was at a maximum.

• **Soviet rocket work** — Logvinov said that since 1951 the Soviet has been making regular soundings of the atmosphere with meteorological rockets. He added that during the IGY, measurements of weather parameters were made by the Soviet in nearly every latitude.

The soundings were taken up to altitudes of 80 kilometers. Temperature and pressure measurements were made through the conventional means of resistance thermometers and pirani-type gages. A mechanical commutator with an operational cycle of five seconds successively switched on the instruments; their outputs were telemetered to earth and recorded on tapes.

Wind vectors were determined through aerodynamics analyses of the flight paths of the heads of the sounding rockets, which were lowered by parachute and tracked by radar.

Here are some of the conclusions in the Soviet paper:

—In the lower stratosphere up to 30 km in moderate and polar latitudes, maximum temperatures occur in the beginning of July, and minimum temperatures in the December-January period. Above 30 km in moderate latitudes, the maximum temperatures are reached in the spring; and in polar latitudes, the maximums are reached in June, and minimums in November.

—Polar latitudes show an appreciably wider temperature-variation than the more moderate latitudes. At 25 km over the Arctic, the temperatures vary during the year between 205°K and 240°K; and only between 210°K and 230°K in moderate latitudes. Near the stratopause, these variations are respectively 235-275°K and 250-275°K.

—In the upper stratosphere, unlike the lower, the horizontal temperature gradient is positive—north is colder than south. The magnitude of the gradient increases with altitude up to the stratopause.

Two oddities were observed: small horizontal gradients in the upper stratosphere in tropical latitudes; and a "certain" shift of the coldest regions from the Pole to the south.

—The Arctic and Antarctic have differing temperature fields in the upper stratosphere. "Zonal type of temperature field in the Antarctic and the distortion of the temperature field in the Arctic may be attributed to the stability of the circumpolar vortex in the Southern hemisphere in winter and to the vortex instability in the Northern hemisphere . . ." ⁂

Saturn Schedule Hinges on S-4 Firing

SA-2 launch called 'complete success,' stress now on 2nd-stage development; Ranger 4 betrayed by its timer

DEVELOPMENT of NASA's *Saturn* booster now hinges on the first static test-firing of its *S-4* second stage, scheduled for late in May.

The official NASA estimate of the big booster's future was made shortly after its eight-H-1-engine first stage thundered aloft last week from Cape Canaveral in its second straight successful launch.

Dr. Wernher von Braun, Director of the Marshall Space Flight Center, called the launch "a complete success."

It took some, but not all, of the sting out of the fourth straight failure in the space agency's attempts to take pictures of the lunar surface with the *Ranger* spacecraft.

A spacecraft malfunction in *Ranger 4*—launched on April 23—killed any chance for the picture taking.

Instead, NASA officials estimated that it missed the moon's leading edge by some 900 miles and thudded into the lunar farside at 9:50 A.M. EST on April 26.

While this was a decided setback to the U.S. manned lunar landing program, *SA-2*—launched on April 25—was a decided boost.

NASA officials declared that it proved irrevocably that large clustered liquid engines have a definite place in the national space program.

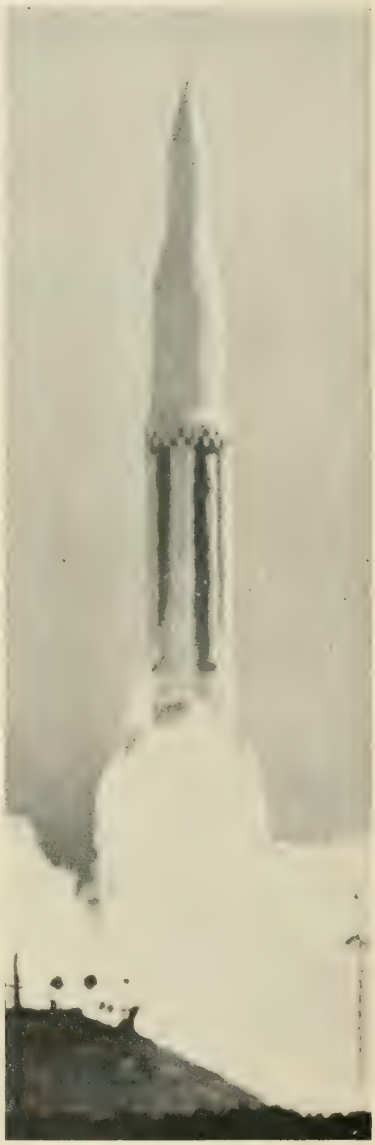
• **The key**—A speedup in the program, they said, will depend on development of the second stage.

A major milestone in the *S-4* stage development will be passed next month when its first static test-firing will take place. A malfunction could delay the program for months.

NASA officials said that the *S-4* development is "going along quite well."

Its first static test-firing, however, will leave only about one year to get it ready for its first test flight—scheduled for *SA-5* in mid-1963.

It is powered by a modified version of the RL-10 liquid hydrogen engine which has caused problems in the *Centaur* launch vehicle, now more than a year behind schedule.



SECOND SATURN takes off on highly successful flight. Vehicle was blown up at 65-mile altitude to create vast ice cloud.

SA-2 was almost a complete repetition of its first launch last Oct. 27.

NASA said preliminary data indicated that it achieved a maximum speed of 3700 miles per hour. Inboard engine cutoff came at 110 seconds following launch; outboard engine cutoff was achieved at 116 seconds after blast-off.

During the *SA-1* flight, maximum velocity was 3607 miles per hour. The vehicle's four inboard motors burned for 109.37 seconds, and the four outboard engines burned for 115.15 seconds.

SA-2, however, also accomplished a new "secondary mission."

The vehicle was deliberately blown up at an altitude of 65 miles to release the 95 tons of water which was carried as ballast in its dummy upper stages.

The water flared into the highest ice cloud known to science since the world began. Space agency officials said that the cloud was 8 to 10 miles in diameter within three sec. after blast and could be seen for miles.

• **Saturn progresses**—*SA-2* was the second of 10 launches in the giant booster's research and development schedule. A third flight is scheduled for later this year, and the entire series is slated for completion by 1964.

It will then be ready for the first phase of the *Apollo* lunar-landing program—the placement of the three-man spacecraft into Earth orbit for up to two weeks.

SA-2 was 162 ft. in height and weighed 927,000 lbs. at lift-off. Its eight H-1 engines developed a thrust of 165,000 lbs. each, for a stage thrust of 1.3 million lbs. In later flights, the engines will develop a thrust of 188,000 lbs. each and a stage thrust of 1.5 million lbs.

Main objectives of the *SA-2* flight included:

—Determination of the in-flight performance of the eight booster engines, the controlling movements of the four gimballed engines, engine cutoff and propellant utilization.

—Verification of the structural integrity of the vehicle's airframe, evaluation of stress at critical moments of flight and determination of vibrations and bending modes.

—Further proving of the launch facilities and ground support equipment.

Besides its Project *Apollo* flights, other possible missions for the *Saturn* include launching of soft-landing stationary or roving payloads of instruments on the moon, probes to Venus and Mars, and 24-hour communication satellites, NASA also said that the booster may be used for other manned Earth-orbital experiments and as a carrier vehicle for nuclear propulsion tests.

• **Zero for ten**—The *Ranger 4* shot was the tenth time that the U.S. had launched a spacecraft to either fly by, orbit or hit the moon. None were successful, although a great deal of scientific data has been sent back to Earth.

By comparison, the Russians have had two spectacular successes in three lunar flights. On Sept. 1, 1959, the USSR put a metal pennant on the moon as the culmination of its *Lunik II* flight. The following month, *Lunik III* took pictures of the far side of the moon.

Prime reliance of the U.S. effort is now in the *Ranger* series, which has recorded four straight failures. In the first two launches the *Agena B* failed to fire correctly; in the third, the *Atlas* booster malfunctioned; and in *Ranger IV*, the spacecraft did not perform correctly.

• **Timer fingered** — JPL said that "on the basis of tentative estimates the problem was in the 400-cycle timer on the spacecraft." The timer was the "master clock" used to send stored commands from the spacecraft and to help route commands from Earth.

JPL said that it hoped to learn more following the study of telemetry tapes from the Johannesburg, South Africa, tracking station.

At launch and while the JPL launch station was tracking the spacecraft, no abnormalities were observed. The timer failed sometime before the Johannesburg station acquired the spacecraft. Engineering telemetry gave the first indication that something was wrong. "We couldn't make sense out of the engineering telemetry, and when we tried to send commands, it didn't respond. We then realized we weren't getting proper sequencing in the timer," JPL said.

Contact with *Ranger 4* was maintained via the main spacecraft transmitter and the 50-miliwatt tracking beacon in the lunar capsule until 10 hours, 32 minutes after lift-off. Then the main transmitter failed, indicating the silver-zinc launch battery had run down. Failure of the battery matched its lifetime of 1000 watt hours, JPL said, indicating that the spacecraft had not extended its solar panels. The high-gain antenna also remained in its launch position.

With no power available and no way of accepting commands, the spacecraft was unable to provide television pictures or trigger launch of the landing capsule.

As a result, JPL estimated that *Ranger 4* passed within 900 miles of the moon's leading edge and at approximately 9:50 A.M. EST, April 26, 1962, it arched to a 6000-mile-per-hour impact on the lunar farside. ⌗

NASA, Pentagon Try to Reconcile Disagreements over AMR

DOD AND NASA officials are attempting to settle a sharp dispute over management of the Atlantic Missile Range.

The major area of disagreement involves the amount of control NASA will have over activities in its new, 75,000-acre manned lunar landing launch sites at Cape Canaveral.

Specifically, NASA wants to initiate its own design, facility construction and support activities without the approval of the Air Force—which has management responsibility for the missile range.

Also involved, to a lesser extent, is a decision as to which agency will provide the $33 million needed to purchase 10.900 acres of land to the north of the Cape.

Details of the dispute were revealed in each agency's answers to a questionnaire prepared by the House Space Committee.

Committee sources said the questionnaire did not constitute an investigation but was simply an attempt to gather needed information. Officials of both agencies said that no attempt has yet been made to take the problem to the National Space Council, but that meetings are being held in Washington and Cape Canaveral between Air Force and NASA officials.

In replying to the questionnaire, NASA said that since it has primary responsibility for the manned lunar landing program, it "must exercise management and funding control over all its aspects."

Because of this responsibility, the space agency said, "it is necessary to follow the Webb-Gilpatric agreement which assigns NASA funding and management authority and designates the Air Force as agent to NASA for master planning."

DOD's reply said the word "agent" simply means that the Air Force has responsibility for fulfilling NASA's needs for range support activities. It declared that range users such as NASA never had a "right to site launch facilities."

The question of responsibility for the siting of launch pads is primarily concerned with the Air Force's upcoming *Titan III* booster.

NASA has already decided where it wants to put its *Advanced Saturn* and *Nova* pads within the 75,000-acre expansion area which Congress has authorized. The Air Force wants to put its *Titan* pads in the southern end of the area. This would force NASA to relocate its pads, to a certain extent.

The NASA position is that this is fine—as long as the Air Force provides the funds for the 10,900 acres it feels will be needed to accommodate all the pads.

DOD, however, told the committee only that it is exploring means by which the land may be purchased if NASA does not initiate the action.

One of the committee's questions suggested that it might be a good idea for NASA to accept overall management of AMR, so long as it provided the same support to all range users now provided by the Air Force.

The DOD reply questioned "the advisability of having an agency whose primary image and defined functions are scientific in nature assume the responsibility as range commander for the development of our arsenal of ballistic weapons and military applications in space."

At Lowry AFB . . .

Titan I Turnover Quickens ICBM Buildup

SAC accepts first hardened operational squadron, faces task of increasing reliability rating of weapon system

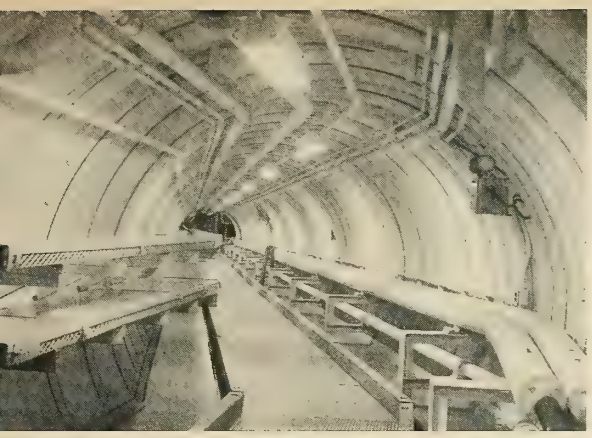
LAUNCH control officer Capt. Preston Maddocks checks console in control center.

DENVER, COLO. — One of the first tasks facing the Strategic Air Command following acceptance of the initial *Titan I* squadron at Lowry AFB will be to increase the reliability rating of the huge ICBM's.

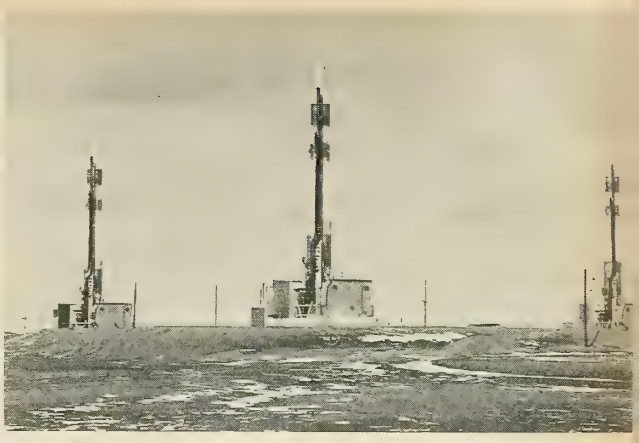
SAC took delivery of the first of six *Titan I* squadrons here on April 18 (M/R, April 23, p. 10). Another nine-missile squadron will go operational shortly.

Reliability of the ICBM's buried underground in 165-ft. silos some 25 miles east of Denver, was rated at 55%

LOWRY'S TITAN I complex is part of greatest peacetime construction job. Some 37,550,000 cu. yds. of earth are being excavated.



ONE OF THE subterranean tunnels connecting the underground silo and propellant terminal with the Titan I blockhouse.



THREE OPERATIONAL Titan I's in first hardened SAC squadron rear above the Rocky Mountain skyline.

on acceptance, the Air Force said.

This is expected to go up sharply as Air Force crews gain experience with the Martin missiles and the underground complex. It already has increased from a figure of 10% two months ago, shortly after the missiles were delivered to the complex and before it was declared operational.

• **Fortress underground**—With the *Titan* missiles secure beneath their 232-ton concrete doors, the underground complex becomes a subterranean fortress, secure from nuclear attack and hardly visible from the air.

The three complexes of the first *Titan I* squadron, the 724th Strategic Missile Squadron, are separated by distances of 10 to 12 miles so that no single nuclear strike could knock out more than three of the nine missiles in the squadron. Complexes of the second Lowry squadron are as much as 50 miles distant.

The *Titan I* complex includes three missile silos, propellant terminals, an equipment terminal, a control center, living quarters for the crews, personnel access silo, power house, antenna silos, and connecting tunnels.

The complex contains sufficient supplies of food, water and diesel fuel to remain buttoned up for a 30-day period. These include 139,000 gal. of diesel oil and 60,000 gal. of water. Crews normally are rotated on duty every 24 hours, with one duty period every three days.

The crew includes two officers and nine enlisted men. Five members of the crew are maintenance personnel, six are operational. The missile wing includes two operational squadrons and one maintenance squadron.

A *Titan I* crew consists of one missile combat commander, one guidance control officer, one missile systems analyst, two missile mechanics/maintenance technicians, one missile system plumber, one refrigeration equipment cooling specialist, two missile electrical repairmen, and two electrical power production operators.

• **Always ready** — Heart of the complex is the deceptively simple control center, 50 ft. below ground and constantly at readiness. Here, in front of three consoles, sit the crew commander, guidance control officer and missile systems analyst, all armed. The panels before them show the readiness of the three missiles, ticking over quietly in the nearby silos, loaded with RP-1 and with power on.

Some 79,500 gallons of liquid oxygen are stored in the complex, instantly available for automatic loading if an alert is signalled. LOXing can be accomplished underground in a matter of from 8 to 15 min.

For a period of one and one-half hours after LOXing, the missiles are ready for firing without further topping.

On command from the control center, the 150-ton missiles can be raised to the surface on the huge American Machine and Foundry elevators in less than 10 minutes.

Due to *Titan I's* radio inertial guidance system, the three missiles in each complex cannot be fired in salvo. The guidance officer would track each missile individually on its course for a period of 15 to 20 min., returning to pick up and guide the following missile. All three missiles could be launched from the complex within an hour after receipt of the firing order, however.

The launch console provides a selection of three targets for each missile. The courses are programed on tape.

• **Safety checks** — Elaborate precautions are taken to prevent inadvertent launch of the missiles. Until the control center receives a green light on its enable-disable panel, the control center cannot launch any of its three missiles. This "unlock" signal requires a positive action both from the command post located at Lowry AFB and from a secondary command post situated in one of the complexes. Thus it takes positive action at three widely separated locations before a missile can be fired.

The *Titan I's* are not equipped for post-launch destruct but can be deviated from course if necessary during the early stages of flight.

In the event the two antennas located in each complex are destroyed in a nuclear attack, the missiles could be guided from another complex which would pick them up after launch.

Blast doors throughout the underground complex are designed both against nuclear blast and detonation of a missile in its silo. Blast lock to each silo consists of two electrically-connected steel doors which cannot both be open at once.

The underground power house of the complex houses four diesel generators, each generating 1000 kw. Normally, two are working, one is kept running in standby status, and the fourth is shut down. Diesel exhaust is piped to the surface.

Also in the power house are ice banks with a capacity of 90,000 lbs. of ice as standby to the 600-kw water chillers which deliver 25 degree temperature water throughout the complex.

The control center, in addition to the control room, includes mechanical and electrical maintenance shops, kitchen and dining hall, ready rooms for officers and airmen, and offices.

Emergency lighting and decontamination showers are provided throughout the complex. Tunnels 10 ft. in diameter connect the various centers of the complex. Distance from the silos at one end to the antennas at the other is some 1200 ft.

• **Fast loading**—One of the features adding greatly to the operational effec-

(Continued on page 50)

Air Force Pleased with Skybolt Debut

Many problems remain, but DOD is hopeful ALBM may come close to meeting late '64 operational date

by James Trainor

A MAJOR MILESTONE for the Douglas *Skybolt* air-launched ballistic missile was achieved last week with the first firing, high over Cape Canaveral, of a development model of the hypersonic missile.

Although the second stage of the solid-fueled missile failed to ignite, Air Force officials termed the test-firing "successful." It proved, they said, the missile's "capability to pitch into a ballistic trajectory after release from the aircraft." It also provided data on the performance of the missile's solid motors and control system.

Designed as a stand-off missile for B-52G and H aircraft, *Skybolt* is to have an operational range of approximately 1000 miles. Due to the second-stage failure, however, it fell far short of this range on its April 19 flight. The exact cause of the failure will not be known until telemetry records of the firing are analyzed.

Dropped from the wing of a B-52G about 20 miles east of Cape Canaveral at an altitude of 40,000 feet, the *Skybolt* fell clear of the aircraft before igniting and pitching upward for its flight down the Atlantic Missile Range.

The 40-ft. missile, under development by the Air Force Systems Command's Aeronautical Systems Division and Douglas Aircraft Co., was loaded aboard the B-52G at the Air Proving Ground Center, Eglin AFB, Fla., and flown to a predetermined launch area over Cape Canaveral.

• **Operational schedule**—Scheduled to become operational in late 1964, *Skybolt* will not only be deployed aboard the B-52G and H aircraft of the Strategic Air Command but also carried by Britain's Vulcan bombers. The Vulcans will carry two missiles; the B-52's will be able to carry four in addition to their normal bombing load.

A British Joint Trials Force, including RAF crews, are now at Eglin AFB for the *Skybolt* testing program.

Originally intended to replace the shorter-range North American *Hound Dog* missile, *Skybolt*, Defense Department officials say, will augment the 500-mile, air-breathing missile. Under this change in plans, SAC's bomber force would have a mix of both missiles in order to give them a greater degree of flexibility and to confuse enemy defensive measures.

AIR FORCE Boeing B-52 shown carrying four Douglas Skybolts beneath its wing.

A B-52 jet bomber, however, can carry only two *Hound Dogs* as opposed to four *Skybolts*. Both missiles have nuclear warheads and are expected to greatly increase the life of the nation's manned bomber force by increasing the B-52's penetrability.

• **Still has problems**—Described by Secretary of Defense McNamara as "a highly complex system operating in a new environment," *Skybolt* still has serious development problems. These stem from the weapon's basic concept of "putting a ballistic missile on an airplane," thereby subjecting it to an "environment of vibration and temperature range that we have not experienced before in connection with our long-range missiles."

The extent of the development problems is well illustrated by the fact that the *Skybolt* program was originally estimated at $170 million but is now closer to $493 million. Funds allocated so far include $149 million in FY '61 and prior, $146.2 million in FY '62 and an estimated $130 million in FY '63.

Candidly admitting that "we still have not seen the end of the development problems," Secretary McNamara has said that he is "less optimistic" than either the Air Force or the prime contractor, Douglas, that the system's operational date can be met. "But if we can solve the (development) problems," he said, "I think the delivery date can be met, or won't slip very much one way or the other."

• **State of Soviet art**—In heavily censored testimony before the House Defense Appropriations subcommittee, AF officials revealed that the Russians have also been equipping their strategic bombers with stand-off missiles.

The Soviets' main, operational air-to-surface missile, according to the AF's Assistant Chief of Staff for Intelligence, Maj. Gen. Robert A. Breitweiser, is a cruise missile mounted on a four-engine turboprop heavy bomber.

However, Gen. Breitweiser said, in addition to cruise missiles on its medium jets, the Russians revealed last summer on their new supersonic medium jet bomber, the Blinder, "a new type of air-to-surface missile more sophisticated and advanced than others. It is a much better missile," he added. ⌘

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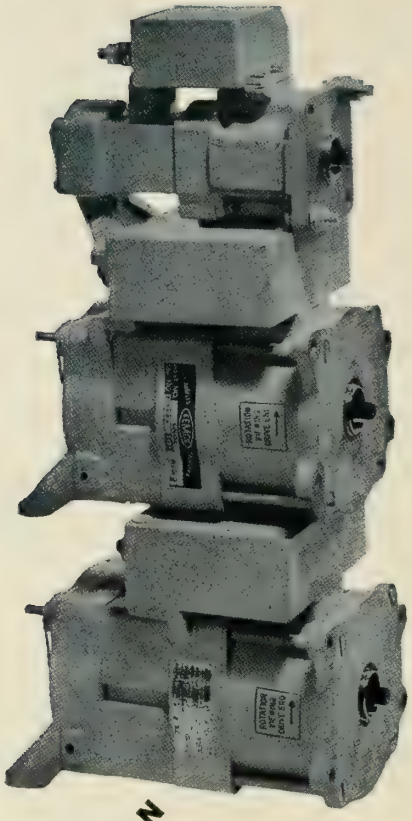

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D-1302 (Third Stage)
Maximum Duty: 1.35 H.P., 14,500 RPM, 24 Volts, 63 Amps, 66% Efficiency.
5 Min. Duty: 1.13 H.P., 19,100 RPM, 28 Volts, 44 Amps, 68% Efficiency, Altitude—0 to 300,000 feet, Life: 100 cycles of 5 min. duty, Weight 4.1 lbs.

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ELECTRONICS

Laser Modulation System Developed

A ruby laser modulation system using a Kerr cell shutter and associated equipment has been designed by Electro-Optical Instruments Inc. for application in optical harmonic generation. The nitrobenzene-filled Kerr cell shutter can easily fit within ruby laser cavities as a Q spoiler for operation in the pulse reflector mode, or in a number of other possible modes. The Kerr cells are hermetically sealed and include integral expansion bellows.

Rare Earth-Doped Liquids for Lasers

Semi-Elements Inc. is investigating the effect of doping liquid lasers with rare earths. The frequency of the output can be varied by introducing a second impurity. The firm has been successful in putting gadolinium, neodymium and samarium into a liquid concentrate. The concentrations are 5% Gd, 2% Sa, and 2% Nd, all in liquid concentrates.

Saturn Ground Computer Contract Awarded

Three ground computer systems to support the *Saturn* vehicle program will be built and installed by RCA under a $1.9-million NASA contract. The units will be delivered to three Marshall Space Flight Center installations, including Launch Complex 37 at Cape Canaveral. The primary function of the system is to provide automatic launch control and checkout capability, to enhance reliability, and to handle the rapid and precisely timed launches anticipated in the *Saturn* program. The RCA 110 computer is the heart of the system.

Azusa Mark I Moves to the Bahamas

In a major cost-cutting move, the Air Force has completed transferring the General Dynamics Azusa Mark I missile tracking system from Cape Canaveral to Grand Bahama Island. The move downrange cost about 25% as much as installing a new system. The Azusa Mark II took over the Mark I's functions at Canaveral in April, 1961. The downrange facility eliminates the exhaust blockage condition existing at Cape tracking facilities when tracking solid-fueled missiles.

PROPULSION

Longest Duration Solid Fired

A 35-ton segmented solid booster reached a firing duration of 130 seconds in a recent test at United Technology Corp. The unit developed a programed thrust of slightly more than 100,000 lbs. for the entire burning time. An advanced thrust vector control system and a new, extended-duration nozzle performed as planned during the test. The nozzle can be directly extrapolated to the huge sizes necessary in multimillion-pound solid boosters.

ADVANCED MATERIALS

Drastic Surface Effects Found in Metals

Changes in strength, plasticity and fatigue life of metals may be produced by removing surface layers of atoms, says Dr. I. R. Kramer of Martin Co. Space Systems Division. One series of experiments aimed at removing surface layers were conducted with the sample bars in an electrolytic bath. As the surface was slowly etched away, the bars were pulled to determine plastic deformation characteristics. Kramer found that dislocations collect in a sub-microscopic layer at the surface of metal specimens.

Plutonium Standard Now Available

The Atomic Energy Commission has prepared a standard chemical sample of plutonium with a purity of 99.97%. In cooperation with the National Bureau of Standards, the sample (No. 949) is available as a comparison standard for all plutonium chemical analysis. The standard was prepared by bomb reduction and then purified by electrorefining. Only persons licensed by the Commission and AEC contractors may obtain the samples.

Plasma 'Eater' Measures Flow Rate

A set of magnetic venetian blinds which measure the flow rate, velocity and density of plasmas has been perfected by scientists at the Oak Ridge National Laboratory. The device is a stack of metal plates placed across the plasma stream. The plasma normally flows between the plates, but if alternate plates are connected to a high voltage, the plasma is pulled apart electrically. Electrons and ions are collected on positive and negative plates respectively. As the plasma is "eaten," the device gives the rate of flow. Once the source is turned off, only the plasma in the magnetic field flows to the eater. The density is calculated by knowing the volume and how much was retained electrically.

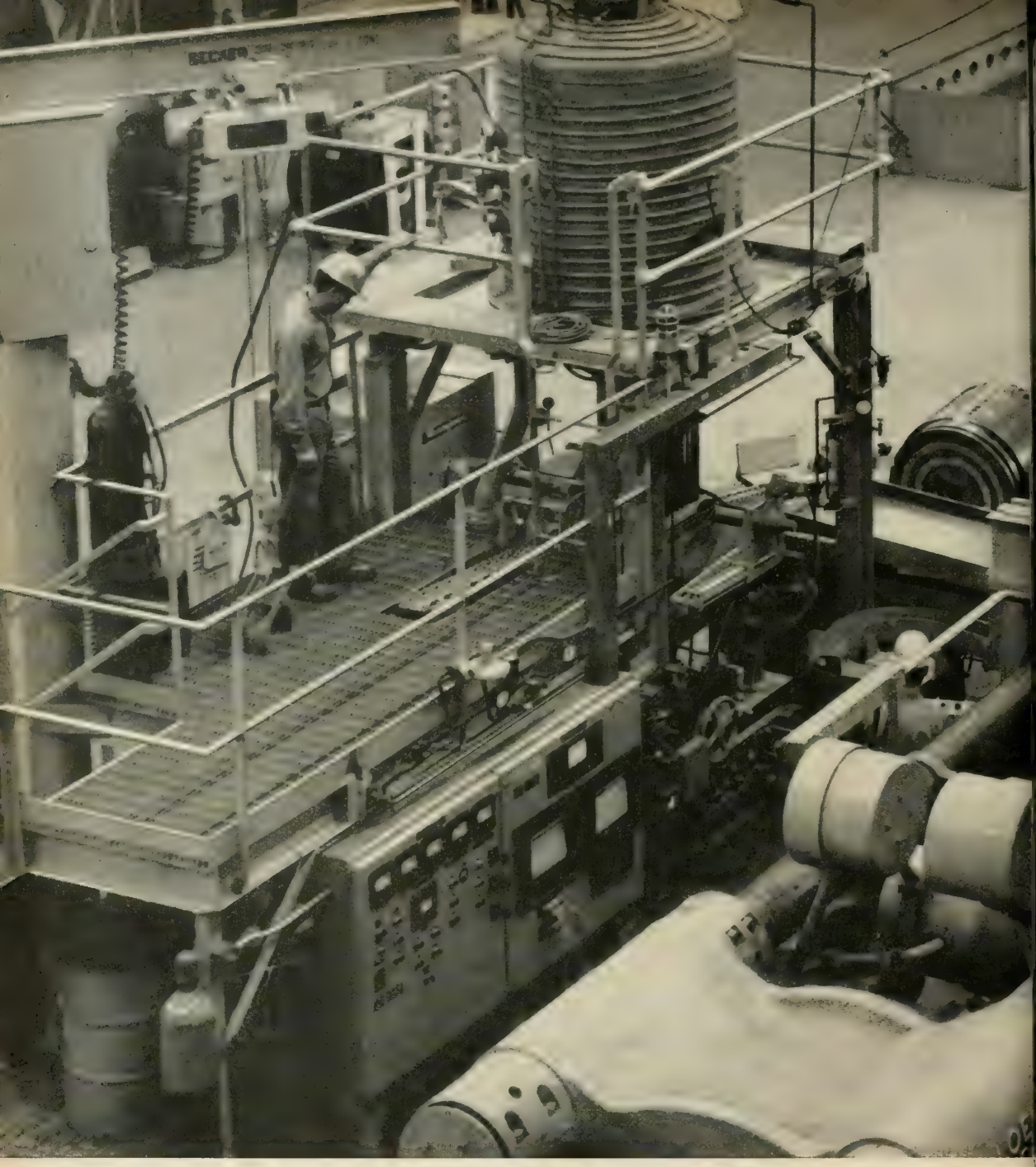
Para-Hydrogen Functions Released

The National Bureau of Standards has computed tabular values of internal energy, enthalpy and entropy of para-hydrogen. The properties are presented together with specific volume as functions of temperature and pressure. The data covers the temperature range 20° to 100°K at pressures up to 340 atmospheres.

SPACE MEDICINE

Soviets Synthesizing Radiation Pill Derivatives

Methods for synthesizing sulfur-containing pyridoxine derivatives to be used as radiation resistance boosters for astronauts have been developed at the Institute of Experimental Medicine of the USSR Academy of Medical Sciences. Isothiuronium and disulfide derivatives of pyridoxine from the corresponding halogen derivatives have been obtained from the isopyropylidene derivatives of 5-chloropyridoxine.



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The Du Pont Metals Center

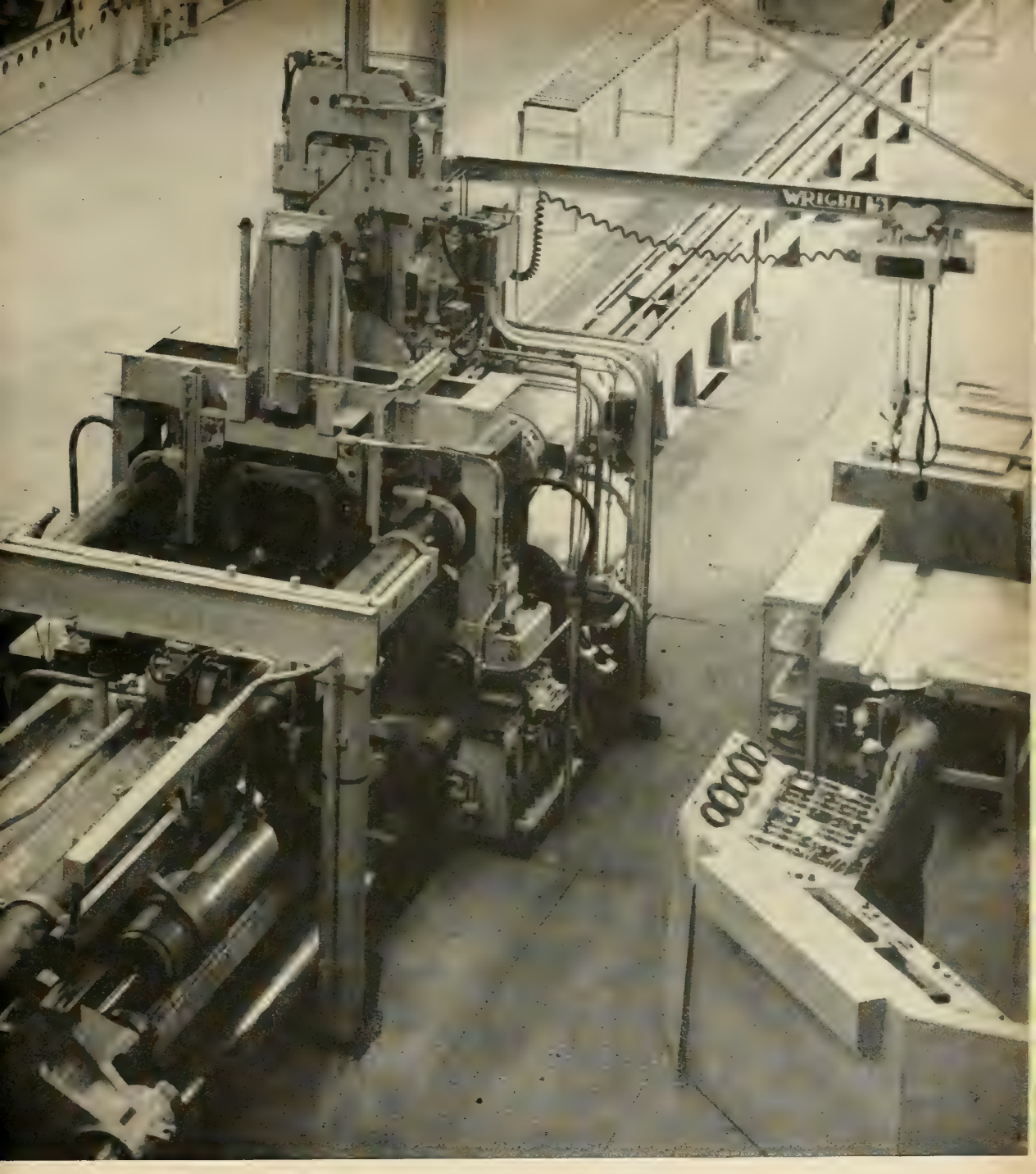
is the only refractory metals plant of its kind

You won't find another extrusion press like this in the U. S. It's the only one designed expressly for columbium and other refractory metals.

It's unique in many ways.

The induction furnace on the left provides contamination-free heating of the billets prior to extrusion.

A specially designed rapid transfer mechanism quickly shuttles the billets



to the extrusion press, minimizing contamination and heat loss.

The press itself is a high-speed 2750-ton unit with maximum ram speed of 10″ to 15″ per second at 2300 tons and 7″ per second at 2500 tons.

This is just part of the remarkable Du Pont Metals Center, the only refractory metals plant of its kind—specially developed from top to bottom for the production of refractory metals.

Du Pont produces ingots, billets, bars, sheet, strip, plate, tube hollows and shaped extrusions. At the Metals Center we are currently producing Du Pont-developed D-14, D-31, D-36 and other columbium alloys. The Center can also handle conversions for *other* makers of refractory alloys and super-alloys.

If you are a prime contractor to military and government agencies, or involved in projects requiring applications for refractory metals, we invite you to discuss your needs with one of Du Pont's experienced metallurgical engineers. For a Data Sheet on Du Pont Metal Products, write to Du Pont, D-2060, Wilmington 98, Delaware.

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REG U S PAT OFF.

How Boeing Won Big Saturn Award

Company built up booster capability for three years before achieving first big contract

by Robert L. Twiss

THE INTENSIVE three-year effort of The Boeing Co. to break into the rocket-booster field is a good example of how hard aerospace industry companies must work to broaden their product base.

Boeing decided several years ago that booster work would be a logical goal in view of the increasingly rapid pace of the U.S. space program and the company's own technological background.

The Seattle firm's first proposal—to win development work on the *Scout* four-stage solid-rocket system — was turned in to the National Aeronautics and Space Administration in March, 1959.

But it wasn't until December, 1961, that Boeing's determination to enter the booster field paid off with a substantial program. Just before Christmas the space agency named Boeing to develop the huge *Advanced Saturn* booster, a cluster of five Rocketdyne F-1 1,500,000-lb.-thrust engines.

Part of the Boeing *Saturn* story is well-known. A team headed by George H. Stoner, now Boeing's *Saturn* branch manager, directed one of the most intensive proposal efforts in Boeing's history in the keenly competitive *Advanced Saturn* contest.

This achievement, as Boeing president William M. Allen pointed out later, was a "remarkable job."

• **Gains with pains**—The successful *Advanced Saturn* proposal had its beginning in the strenuous but unsuccessful bid by a different Boeing group to win the *Scout* award.

In losing that competition, the Boeing proposal team, headed by Douglas E. Serrill, achieved two important "firsts" for the company. It marked Boeing's first business contact with the space agency and also served as the company's introduction to booster systems for launching payloads into space.

Serrill and his associates, after losing the *Scout* bid, went back to tedious preliminary design studies, this time in the area of large boosters. Of particular interest to the group were lunar and earth-orbital system studies involving *Saturn* and *Nova* boosters.

Events began moving rapidly. Many of them were to have a bearing on the Boeing *Saturn S-1C* proposal two years later.

In a move to combine a variety of talents and organizations into a single organization to cope with Space-Age assignments, Boeing formed its Aerospace Division. One outcome of this was the establishment of the Booster and Space Vehicle Section under Harlowe Longfelder. Serrill was one of Longfelder's key men.

On the other side of the United States, meanwhile, a committee composed of officials from NASA, the Army Ballistic Missile Agency and the Department of Defense met and recommended the use of hydrogen and oxygen as fuels in the upper stages of the proposed *Saturn* booster.

That decision was a blow to Boeing's hopes of winning future business in the *Saturn* program. Despite its technological depth, the company had only limited experience with the cryogenic fuels. Clearly, if Boeing meant to establish a foothold in the booster field, it had considerable ground to cover in this vital area of study.

Boeing management authorized research studies and the expansion of its new Tulalip Test Site facilities, about 30 miles north of Seattle on Tulalip Indian Tribe land, to include work with cryogenic propellants.

The 11th-hour "cram" session got under way.

HARLOWE LONGFELDER (left), manager of Advanced Space Systems Department, and Hua Lin, unit chief of Advanced Missile Systems, Aerospace Division.

Slosh tests were conducted with hydrogen to determine the effect of the liquid fuel on controlling boosters in flight. Steel and aluminum tanks were purposely blown apart, in a study of the behavior of metals at extremely low temperatures. Welding techniques were studied and improved.

The test of how much Boeing had learned was not long in coming.

Boeing was invited to submit a proposal on the *Saturn S-IV* stage. This was its first big venture toward getting large liquid-rocket business in the field of high-energy cryogenic propellants.

Boeing didn't confound the experts in that competition. Its *S-IV* proposal failed. Boeing research and ingenuity, however, seemed to be building the right foundation. Reports indicated it had placed well up in the contest.

Longfelder and other members of the team—Serrill, John Cully, Hans Bebie, Hua Lin, Hal McClellan and others—took stock of the Boeing booster progress when results of the *S-IV* contest were received.

• **Strengthening**—The group could see shortcomings in the Boeing proposal; they determined to correct them for future competitions.

"For one thing, we had to strengthen our associations with the technical personnel at NASA," Longfelder said. "We had to keep in touch better, develop a technical and management interchange of ideas and more clearly demonstrate the accomplishments of our work in Seattle."

Serrill saw to it that key personnel in the company's new business and technical staff groups got in touch with NASA at regular intervals. Top management officials in the Boeing Aerospace Division also were brought in touch with space agency officials.

NASA personnel were invited to visit Boeing's Seattle facilities. The cryogenic program was accelerated.

But success continued to elude Boeing's efforts in the second half of 1960. First, the company lost out on bids to win booster study contracts. In October, 1960, Boeing sought to win the contract to build the 70-in.-dia. propellant tanks for *Saturn S-1*. Confident now of its ability to build the tanks for cryogenic fuel, it hoped to use this job as a stepping stone to the *S-1* assembly and test contract, which loomed in the future.

Out of 13 original proposals submitted to the space agency, the Boeing bid was one of four selected for final competitive negotiation. Boeing lost.

"It was a tough one to lose," Serrill recalled.

But the booster work went on.

To further strengthen its communications link with NASA, Boeing opened an office at Huntsville, Ala., site of the Marshall Space Flight Center. T. P. Snow, for 10 years one of Boeing's officials working with the Air Force in Dayton, Ohio, was named to head the office.

DOUGLAS E. SERRILL, assistant director of engineering, Saturn Booster Branch.

In April, 1961, Boeing decided to pass up an opportunity to bid on the *Saturn S-II* contract. One requirement was for a large land test area adjoining or close to water transportation. Boeing lacked such an area.

BOEING'S Saturn S-4 proposal. Company lost but placed high in competition.

In hopes of improving its capability in this respect, the company began negotiating with the State of Oregon for a potential test site in the Boardman area of Northeast Oregon, adjoining the Columbia River.

• **Pay off**—In May, 1961, Serrill's group submitted a proposal to NASA for a study involving the clustering of large solid rocket boosters for space missions. This time, the Boeing efforts paid off.

In July it was announced that Boeing had been given an assignment to determine the most effective method of clustering large solid boosters for space flight. The contract amounted to about $100,000, but it was worth considerably more to Boeing in terms of new hope for a future in boosters.

Meanwhile, Serrill's booster section had been investigating the company's ability to assemble and test the first stage of the *Saturn* launching vehicle, which NASA was working on at Huntsville. The job eventually would be turned over to an industrial contractor, and Longfelder and Serrill were convinced Boeing could handle it.

In July, 1961, Robert H. Jewett, vice president and assistant general manager of the Aerospace Division, and Serrill went to Huntsville and Washington, D.C., to learn more about it.

Briefings from space agency officials satisfied them that Boeing, with all of its background, could win the *Saturn* assignment—if it could generate a top proposal.

Two competitions were involved—one for the *S-1* and one for the larger *Advanced Saturn* booster stage, the *S-1C*.

The responsibility for shaping these proposals was given to the team headed by Stoner, who had been a key man in Boeing's early *Dyna-Soar* space-glider efforts.

Relying heavily on information and experience gained by Longfelder's group, the Stoner team went to work. What happened is aerospace-industry history: the Chrysler Corp. won the *S-1* and Boeing the *S-1C*.

The major part of the *S-1C* assignment, of course, still remains to be accomplished. Serrill, who earned a permanent place on the *Saturn* team will be a part of Boeing's work force at the Michoud plant in Louisiana, believes reliability will be a critical factor.

"When you consider the cost of each of the first-stage boosters, or for that matter, the potential loss of the upper stages and payloads in the event of failure to the first stage during launch, you can understand the importance of being right the first time," Serrill said. "This will be one of the most challenging technical jobs that Boeing has ever undertaken." ⌗

'Photopot' Qualifies for Many Jobs

Giannini's new solid-state potentiometer with no moving parts has wide range of future applications

by Arthur H. Collins

DUARTE, CALIF. — A recently developed solid-state potentiometer with no moving parts is expected to find wide application in instrumentation and data systems—with additional possibilities in star-seeking navigation systems or nuclear blast detection.

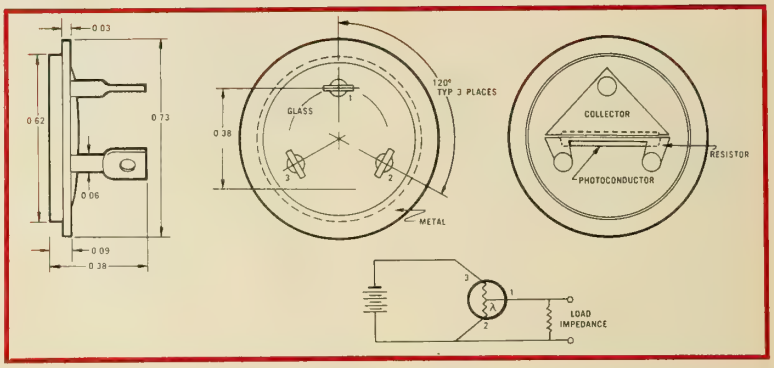
The versatile device has been dubbed Photopot by its developers, the Solid State Physics Group, Giannini Controls Corp. It is an electro-optical semiconductor analog of the mechanically operated potentiometer. The mechanical wiper arm of conventional potentiometers has been replaced by a tiny light beam.

The photopot consists of a photoconductive crystal containing parallel deposits of a resistive film strip and a non-resistive collector. Voltage applied to the resistive strip is divided by light falling upon the photoconductive gap. The photoconductive material acts as an insulator when in the dark or as a conductor when illuminated. A small light beam serves as an electrical connection only at that position where it connects the resistive and conductive strips.

The photopot is insensitive to changes of light intensity over very wide limits. It operates on low d-c voltage (5 to 50 volts), offering outputs of either ac or dc without need for amplification. Output voltage is a linear function of light beam displacement on the crystal, but functional outputs can be obtained for any special application.

• **Utilization**—Two typical methods are employed. The first consists of a fixed shield covering all but a narrow slit opening to the photoconductive crystal and placed at a small distance from the crystal. Light source movement is sensed as an angular displacement since the beam of light is in a direct line from the source, through the slit, to the photoconductor.

The second method involves a light source fixed with respect to the photopot, and a movable shield with its slit. Mechanical movement of the shield is sensed and translated into voltage without the use of friction-operated mechanical wiper arms. Output voltage is a linear function of light beam displacement on the crystal.



DETAILED physical specifications of the photopot and its equivalent circuit.

There are many photopot applications. It is best suited for direct light-position measurements, says Giannini, pointing out that angular displacement down to tens of arc-seconds can be clearly resolved. Possible applications include:

(1) Nuclear blast detection: The photopot could be used as an atmospheric nuclear blast detector. Because the device is entirely solid state and not a seismic indicator, it would not be "fooled" by an earthquake.

Light intensity from a 20 kt. bomb will operate the device at many miles from detonation. Blast yield may be calculated by comparing light intensity against time. A photometric device coupled with a photopot could form a remote station to provide blast position and yield.

(2) Optical activated potentiometers: Pressure, temperature and accelerometer instruments fall into this category. Giannini says the photopot offers noise-free operation, with no mechanical contact problems of wear and skipping. Lack of parasitic voltages in the photopot makes the device useful in many specific applications. Further and equally important, the company notes, noise levels will not build up with use or time. Frictionless properties of the device avoids hysteresis and "dead spots."

(3) Direct analog conversion of signal shape: Giannini has demonstrated photopot capability to translate linear motion into a programed non-linear output and vice versa. This data processing technique may be employed in many applications or used for its own sake. The data program to be followed may be built into photopot system optics, eliminating additional components.

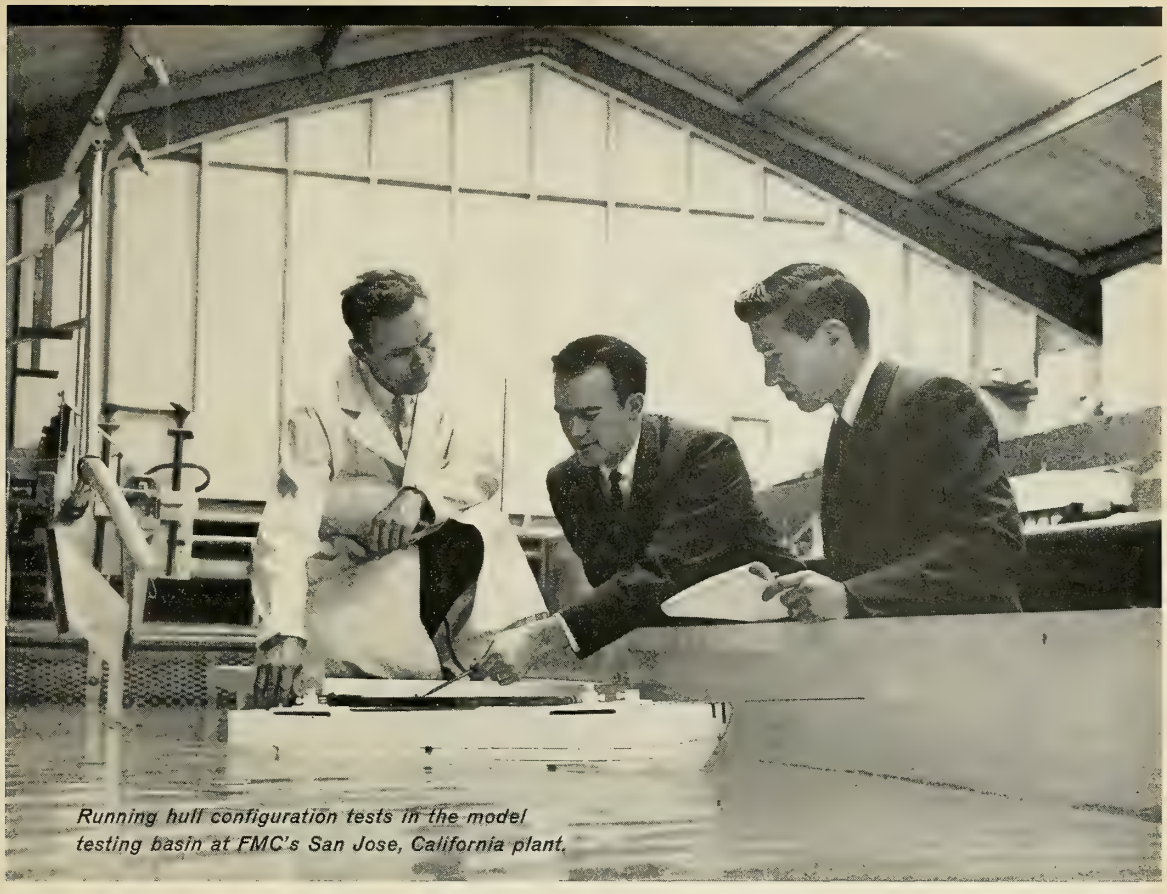
(4) A frictionless, noise-free potentiometer: No mechanical wiper arm is used.

(5) A linear position sensor: Photopot output voltage is a linear function of light beam displacement of the crystal.

(6) Stellar-body position indicator: For navigation of missiles and satellites.

(7) Look-angle indicator: To track the position of a fast-moving flare, where systems rely wholly on sensor ability to follow position changes at high speed.

(Continued on page 37)



Running hull configuration tests in the model testing basin at FMC's San Jose, California plant.

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For details on employment opportunities, write Mr. George A. Reynolds, Manager of Development Engineering, FMC Ordnance Division, P.O. Box 367, San Jose, Calif. Include resume of background and professional qualifications.

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PUTTING IDEAS TO WORK FOR NATIONAL DEFENSE

Lamtex Progress In Reinforced Plastics:

A VITAL FACTOR IN SPACE AGE TECHNOLOGY

An important though unheralded American triumph in the space era has been the success achieved in developing new materials to shoulder the critical burdens that conventional materials cannot bear. Lamtex Industries, Inc. has been in the forefront of this development, making significant contributions to the state-of-the-art of modern reinforced plastics. Advanced Lamtex research, processes, and equipment have broken through rigid material design conventions by providing optimum quality reinforced plastics for crucial tasks in space, military weapons systems, underseas, and to meet the more exacting demands of industry.

Lamtex reinforced plastic products outstrip ordinary materials by any measure. Compared to steel, for example, HYSTRAN®—Lamtex's exclusive filament wound reinforced plastic—weighs half as much, has a strength-to-weight ratio 270% higher, and cuts R&D, tooling and production costs by more than 50%. As much as two years' faster delivery can be made of Lamtex HYSTRAN rocket engine cases than of steel cases. If you're keeping score, also add these advantages resulting from the use of Lamtex reinforced plastics: superior thermal and electrical insulation; greater resistance to corrosion, impact and shattering; the safety of being non-magnetic and non-sparking; absence of notch sensitivity problems; wider versatility in choice of size and shape.

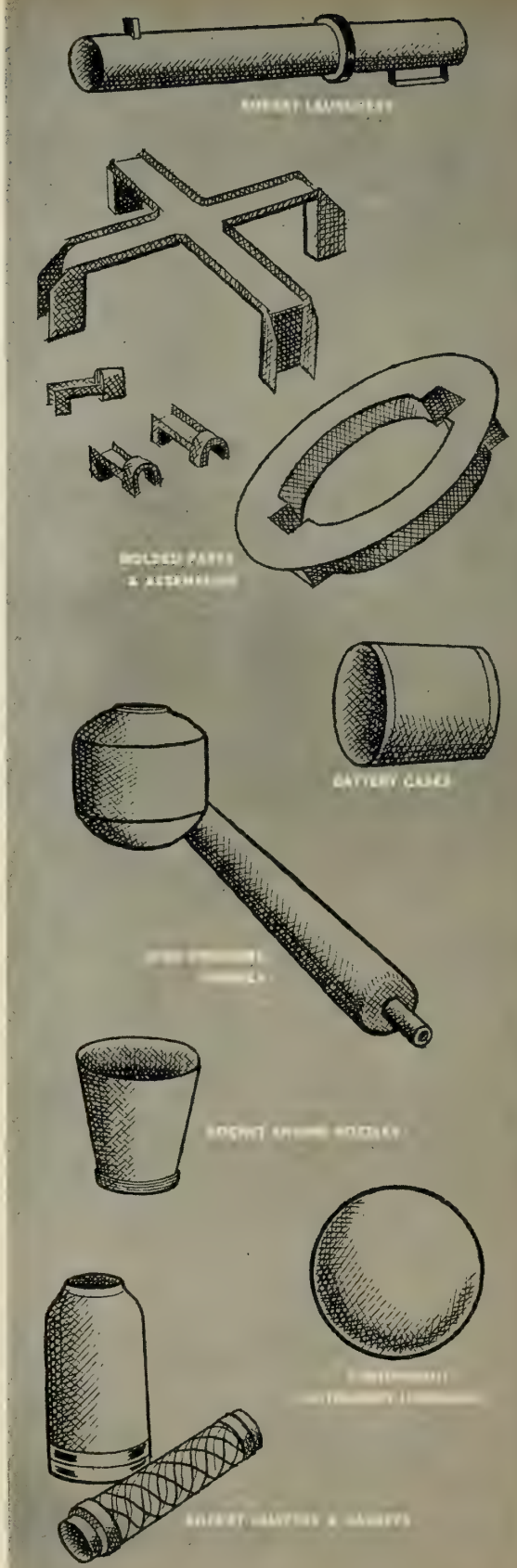
As befits a leader in its field, Lamtex offers the broadest line of high quality reinforced plastics. HYSTRAN filament wound structures are solving design and material problems previously considered impossible or highly impractical. Lamtex's Custom Molding Facilities are capable of producing parts and assemblies in a wide range of sizes, shapes, and cross-sections by Matched-Die, Autoclave, and Vacuum Bag processes. "Sheet" HYSTRAN is a unique new raw material combining the shape flexibility of molding with the strength preorientation of filament winding.

Some of the major space, military and commercial projects currently using Lamtex reinforced plastics include: MINUTEMAN, MERCURY, POLARIS, PERSHING, SCOUT, BOMARC, RANGER, NIKE-ZEUS, VORTAC, DISCOVERER, BOLT, LAW and a variety of NASA projects.

Whether your material problem involves weight, stress, temperature, corrosion, insulation or any combination of those factors, Lamtex reinforced plastics can probably help you. Complete technical and cost proposals will be submitted without obligation—we have even produced actual product samples to prove that "it can be done by Lamtex". Why not let us prove it to you?

LAMTEX INDUSTRIES, INC. Farmingdale, L.I., New York

LAMTEX



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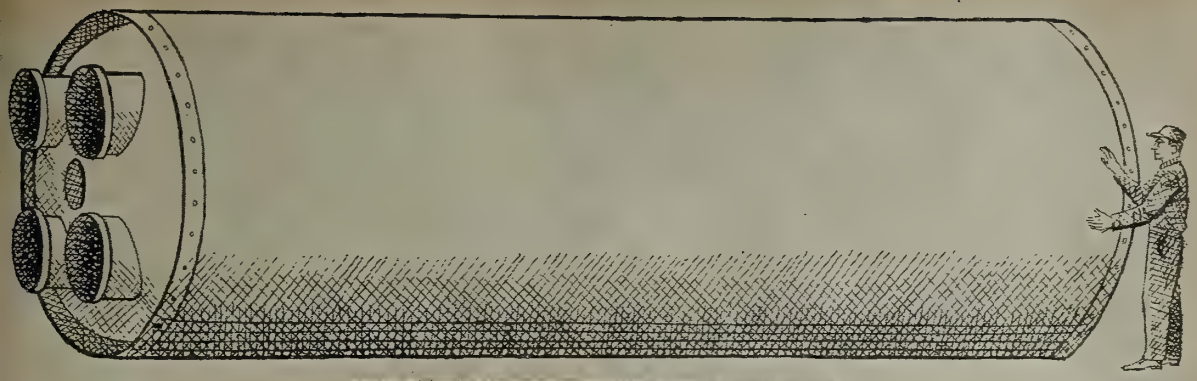

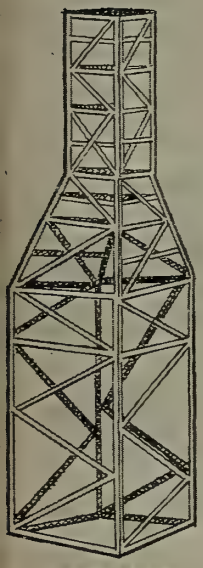

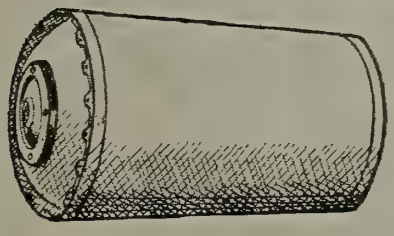

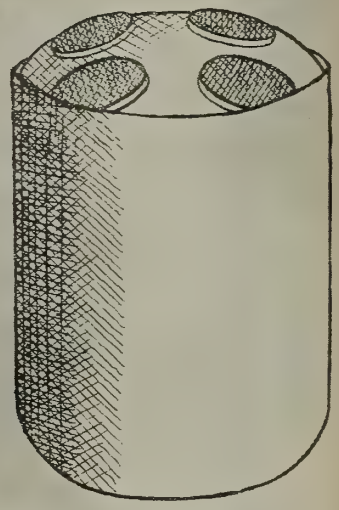

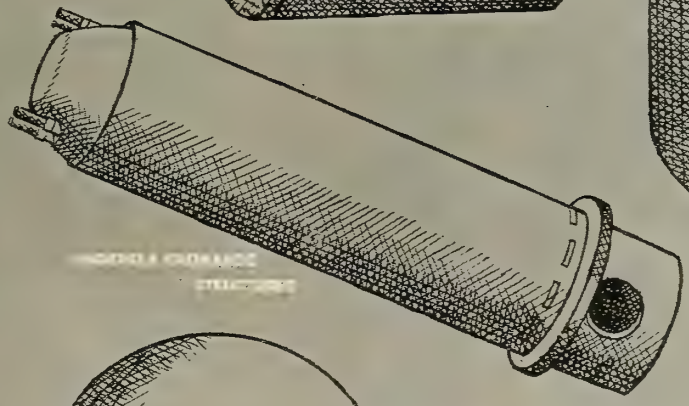

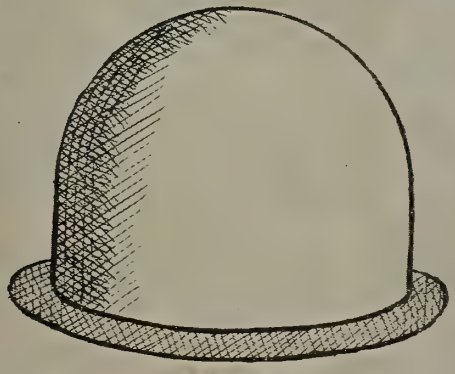

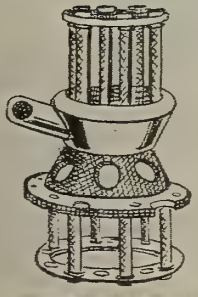

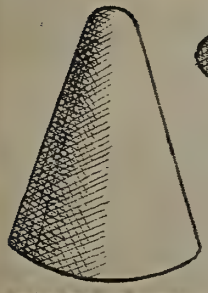

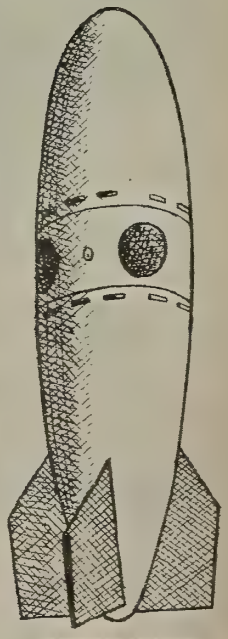

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These unique rubber liners, produced by B.F. Goodrich, protect Polaris second stage glass filament wound rocket cases from the high erosion and flow of expanding gases in the 5000 degree F. temperature range. Without the liners, the cases themselves would have to be designed much heavier to withstand this pressurized inferno.

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Rubber is a material you might not consider for containing such high temperatures. But in view of the time dimensions involved, rubber often does the job better than any other material. And B.F. Goodrich does the job of precision manufacture of rubber and rubber-like products for a wide range of aerospace requirements.

For information on BFG capabilities in heat-resistant materials, products, and structures write *B.F.Goodrich Aerospace and Defense Products, a division of The B.F.Goodrich Company, Dept. MR-4, Akron, Ohio.*

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New SINS Nears Sea Tests

by Charles D. LaFond

SEA TRIALS will begin this summer for a new, highly advanced Mark 4 Ships Inertial Navigation System (SINS) designed to be used on *Polaris*-type submarines.

Results of the tests, aboard the USS Compass Island, will determine if and when the system will be used. Both existing SINS suppliers—Autonetics Division of North American Aviation, Inc., and Sperry Gyroscope Company—are competing with updated systems of their own for the six Fiscal 1963 *Polaris* subs.

Three years in development, the new Mk-4 SINS was designed by Massachusetts Institute of Technology. It is reported to be one-third the size of the present operational SINS—and to provide at least a magnitude increase in accuracy.

However, as is the case with all major systems used in the Navy's *Polaris* subs, it must not only prove itself with respect to reliability, accuracy, and maintainability; its developers must demonstrate that it can be produced, tested and delivered on schedule. Apparently, insiders say, the Mk4 R&D program has slipped considerably. As of now, informants feel that at best the new system might find its first use in the six missile submarines expected to be funded in FY '64.

• **Not interchangeable** — None of the SINS produced by the three organizations—either present or future—are interchangeable.

However, all have certain basic design characteristics.

The primary SINS function is to determine true north, true vertical ship's position, and the ship speed necessary for accurate firing of *Polaris* IRBM's.

SINS must have the capability at times to permit steering a submarine to any predetermined position without using external reference points.

Each SINS employs a 3-gyro stable platform for directional control, accelerometers and a velocity meter for determination of distance and position.

Each sub carries three complete SINS. External corrections are provided from a celestial navigation system, radio navigation system, and two general-purpose digital computers.

• **Fastest with the mostest**—Possibly because it developed and proved its Mk2 SINS first, Autonetics has obtained the lion's share of SINS production contracts in the past. It may well do it again, observers say.

The score sheet looks like this so far: NAA has its Mk2 Mod0 on all five boats of the 598-class and on the nine subs of the 616-class funded in FY '61; a more advanced system, the Mk2 Mod2, is supplied by NAA for the 10 616-class boats funded in FY '62; Sperry's Mk3 Mod0 SINS will be installed in all five of the 608-class boats.

• **R & D Program**—Following development of its prototype SINS, MIT proposed in 1959 to build an advanced SINS for use in oceanographic ships at Woods Hole, Mass.

The Navy, however, felt that an improved system should be developed as a follow-on to the existing SINS. It began funding the R&D program. About $12 million has gone into the new system so far.

The stable platform used in the Mk4 is based on an all-new design using new miniature gyros and employing spherical gimbals.

MIT has built the prototype platforms and Northrop Corporation is building all the associated electronics for the Mk4. The company also is responsible for final system assembly and test.

Under a $3 million (approx.) contract, Sperry has developed its Mk3 Mod3 SINS. It is an improved version of its earlier system, in which the principal change has been the conversion to a complete digital computer system. The stable platforms also will use improved gyros.

Developers are reported to believe they have greatly increased accuracy, reliability, and flexibility with the improved system.

The Mk3 Mod3 uses new component-monitoring techniques which could contribute to increased system accuracy. The highly touted gas-spin gyros now being used in the operational Mk3 Mod0 platform have been carried over to the advanced system. Principal areas of improvement include the computor and inertial elements—both advanced gyros and a new velocity meter.

Systems tests of the Mk2 Mod2 will be made late this summer. The company reportedly expects to be ready to make deliveries in the fall. ⌗

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ARC Gets Gel-Solid Award, Expands

FIRST MAJOR expansion of Atlantic Research Corporation's large-solid-rocket facilities has followed close on the heels of an Air Force contract to prove feasibility of the gel-solid space booster concept.

The nine-month, $500,000 contract and resulting expansion are seen by ARC as "the first step in some really big things for us." The firm is confident of continued growth in the field, including follow-on contracts for work on the gel-solid concept. Up to $1 million may be invested this year in the facility, located at Corolla about 40 miles north of Nags Head.

One test stand and an electronic instrumentation van have been installed at the site, which is already equipped with 10 buildings for office space and living quarters, and concrete is being poured for additional facilities. Eventually, ARC hopes to build fabrication and assembly buildings for large gel-solid boosters, which will then be transported to launch sites via the nearby inland waterway or Atlantic Ocean.

The 5000-acre site, designated by ARC as its Outer Banks Facility, is now being used for static firing of some small rocket motors, but not in the gel-solid program. Initially, the company plans to use the area only for testing.

The site is five miles from the mainland and currently reachable only by water, although the firm is using helicopters and light planes for access. A road will be built from Nags Head soon. The site has eight miles of frontage on the Atlantic Ocean and is backed up by Currituck Sound.

• **New concept**—Air Force Systems Command, which awarded the contract to ARC, has released neither timetables nor motor sizes involved in the gel-solid program.

The gel-solid booster employs a new concept in which a toothpaste-consistency propellant is transported to the launch site in tank cars, then pumped into the pad-mounted motor casing. A central exhaust stack conducts gases to the nozzle during burning, and the propellant is held on trays within the casing. The propellant thus burns on its upper surface, and the number of trays can be altered, much as in any other segmented concept.

The company says its gel-solid propellant behaves ballistically like a solid propellant and has the same reliability, but offers much lower cost and shorter development time. It is easily transported in railroad tank cars to a desired site, then pumped into the rocket case in any quantity, being particularly suited for very large first-stage boosters. ⌗

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Aeronca Explores Thermantic Structures

by John F. Judge

A COMPOSITE structure combining the high thermal shock resistance of porous ceramics and the structural reliability of high-alloy metals is being explored under Air Force sponsorship at Aeronca Manufacturing Corp., for re-entry and high-speed atmospherical applications.

The composite—thermantic construction—divides the load-bearing and insulation tasks in a single, integral panel. The load-bearing, or back-up, structure consists of a lightweight, high-strength metal such as steel or one of the Inconels.

Protection is provided by foam ceramic in small, honeycombed cells. This ceramic handles both the radiation heat and insulation. A second layer of fibrous or particulate insulation is used under the ceramic layer. The whole panel is brazed at one time.

The key to the structural thermal protection concept is in the ceramic bonding. This bonding of ceramic-type materials to conventional aircraft structures has long been considered unreliable, because of the poor thermal shock resistance and brittle nature of the ceramics. Aeronca handles these two problems in the thermantic concept by breaking the ceramic surface into small cells allowing the absorption of stresses caused by thermal expansion, temperature, gradients and loading.

The ceramic is loaded in open-faced honeycomb fashioned from super alloys. This honeycomb has been brazed to a honeycomb-sandwich load-bearing section. A fibrous or high efficiency insulation is applied between the ceramic and the load-carrying panel.

The outer surface of the ceramic is treated to achieve a high emissivity. Aeronca specialists did not disclose the exact process involved but two general methods were discussed.

One means of raising the emittance is through the addition of metal oxides such as manganese, iron, nickel and possibly copper. The other method involves an extremely thin ceramic coating of high density. Work is progressing on these thin coatings in an attempt to include a variety of properties besides emissivity—mechanical strength, thermal shock and erosion resistance.

Porosity control in the ceramic foam cuts down the thermal conductivity and serves to reduce weight. The high surface temperatures generated in an operational environment result in radiation rejection of all but a small incident heat fraction.

Ceramic technology is the pacing factor in the growth of thermantic structures. Now being pressed are investigations aimed at reducing the reinforcement requirements. For example, the reinforcing honeycomb cell diameter has been increased from 0.25 to 0.50 in., and larger cells are being planned.

• **Concept potential**—Aeronca experts see possibilities of extending the ablative functions of ceramics and plastics. In supercircular re-entry, for instance, a portion of a ceramic or plastic component may ablate — but when speeds are reduced the remaining portion would act as a radiation cooled structure.

Transpiration cooling during superorbital velocities is also compatible with porous ceramic heat shields. In such a system, the fluid may be ejected through ports connected to an internal compartment cooling system.

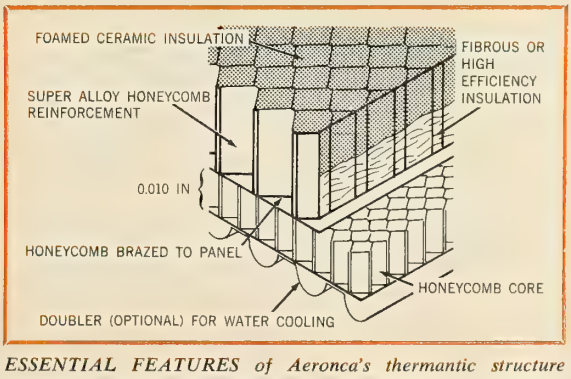
The ceramic materials receiving greatest emphasis at Aeronca are silica, alumina and zirconia. All have been prepared in the porous form with properties satisfactory for re-entry applications.

Densities of 30 lbs./ft.^{3} have been obtained with silica. Alumina densities range between 40 and 45 lbs./ft.^{3}, while zirconia runs 60 to 65 lbs./ft.^{3} This last is expected to reach 40 lbs./ft.^{3} through foam development.

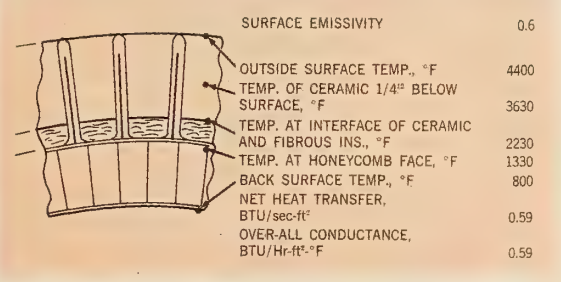
These porous oxides adequately resist surface temperature of 3000°F and can be prepared without using temperatures in excess of 1000°F. To develop a strong bond at these processing temperatures requires the use of stable cementing materials or low-temperature reactions not usually involved in the processing of ceramics.

Inorganic bonding materials which do not appreciably lower the melting point of the refractory grains are required to handle the ceramic at temperatures under 1000°F. Aeronca has used phosphate, oxychloride, fluorophosphate and silicate bonding systems. For each of the refractories, certain of these systems are optimum.

Organic binders such as modified phenolics and the polyvinyl alcohols frequently can be used to provide extra strength at low temperatures. These decompose in intense heat, but in so doing generate gas which absorbs heat and provides surface cooling. ⌘



ESSENTIAL FEATURES of Aeronca's thermantic structure illustrate the divided load-bearing and insulation characteristics in one integral panel.


SURFACE EMISSIVITY 0.6
OUTSIDE SURFACE TEMP., °F 4400
TEMP. OF CERAMIC 1/4" BELOW SURFACE, °F 3630
TEMP. AT INTERFACE OF CERAMIC AND FIBROUS INS., °F 2230
TEMP. AT HONEYCOMB FACE, °F 1330
BACK SURFACE TEMP., °F 800
NET HEAT TRANSFER, BTU/sec-ft² 0.59
OVER-ALL CONDUCTANCE, BTU/Hr-ft²-°F 0.59

CROSS-SECTIONAL VIEW of one structural shape under investigation for applications at 4400°F surface temperatures. With an incident heat flux of 160 BTU/ft.²-sec., the heat transmitted to the interior is only 0.59 BTU/ft.²-sec.

NEW TWIN TRANSDUCERS

Give data continuity for ground and airborne pressure tests

Two new members of the CEC family of high-range pressure transducers – the ground-based 4-350 and its airborne twin, 4-329–give you data in figures that are immediately comparable. Because they have the same sensing elements, performance curves are the same.

Type 4-350 is rugged. Cased in 17-4PH SS to resist corrosion and severe test-stand conditions, it features a unique 10-X overpressure stop–assures safety plus continuing precision during successive test usage. Price: $360.

Type 4-329 is lightweight–aluminum-cased for flight use. It has the same pressure range as 4-350: 0-100 through 0-5000 psia or psig. Price: $395.

For more facts, write for Bulletins CEC 4350-X5 and 4329-X5, or call CEC sales and service office.

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This heating is usually so rapid that self-bonding develops simultaneously with the organic bond breakdown—a desirable combination of properties.

The low-density insulations backing up the ceramic honeycomb come from a number of commercial sources. Aeronca experts have used fibrous *Min-K* and *Micro Quartz* produced by Johns-Manville, *Santocel* by Monsanto and potassium titanate fibrous insulation from DuPont.

Low-conductivity materials have been combined as fine powders or fibers to further reduce the conductivity. Thermal radiation is partially controlled by dispersion and diffusion in the fine particles of fibers and through opaque constituents.

These insulations are extremely effective to 1500°F, but some reduction in properties is to be expected in the 2000° to 2500°F range.

In the metals area, high-temperature alloys are available for use in the metal sandwich back-up structure and in the outer reinforcement honeycomb.

The hot face of the back-up panel will be in the 1000°F temperature level in an oxidizing atmosphere, and iron-base or nickel base superalloys of the age-hardenable type can be used.

• **Selectivity problems**—Metal selection is much more limited in the outer honeycomb. Its operational environment is severely oxidational and near the melting point of the metal. Besides oxidation resistance and high temperature strength, alloys used as reinforcement honeycomb must be capable of reduction to thin foils.

Aeronca specialists say several factors reduce the severity of the operating surface temperatures, and the concept of a metal reinforcement is not as marginal as it appears when these temperatures increase.

The metal contributes a portion of the total conduction path; while this is kept to a minimum, the foil temperature levels are considerably lower than the ceramic. The heat sink existing in the first sheet of the sandwich structure prevents localized failure at the braze.

The final factor is the oxygen impedance ability of the ceramic. Any oxidation-resistant coating on the metal provides further protection.

Selection of correct foil materials and protective coatings is an absolute requirement for this type of structure—regardless of the ceramic foams used.

A program to apply beryllium to the thermantic structure is under way at Aeronca. The firm is under contract to the AF's Aeronautical Systems Div. to explore fabrication techniques in brazing beryllium structures. Beryllium shows considerable potential for reducing structural weight. ⌗

Giannini's Photopot

(Continued from page 28)

Photopots have demonstrated the ability to measure high light spot velocities. With a system having a 1000:1 optical lever arm ratio, the light source speed measurable with this system is about 20,000 ft/sec., according to Giannini.

(8) Verticality indicator to measure pendulum displacement; a Coulomb meter instrument to measure integrated electrical current; an instrument to measure frequency and amplitude of sonic vibrations; and a strain gauge.

• **Resolution**—Photopot resolution is said to be better than 0.0005 over an active length of 0.5 in., and Giannini engineers believe this can be improved to at least 0.00005.

• **Sensitivity** — The ratio of crystal resistance between conditions of dark and light photopot sensitivity using CdSe as the photoconductor, presents ratios of 10^6 at 1000 microwatts per cm^2 of radiation between 7000 and 7400 Å. Other materials have peak response down to about 5000 Å or even into the ultraviolet.

• **Response speed** — Main concern is scanning rate or sweep speed. In practical use this is found to be as high as 400 cm/sec.

• **Linearity**—The maximum allowable deviation from the best fitting straight line drawn between the 15 and 85% voltage points, expressed as a percentage of peak output voltage. This is customarily less than ± 1.0%. Photopot deviations of less than 0.2% have been observed over a range of 10 to 90% full voltage.

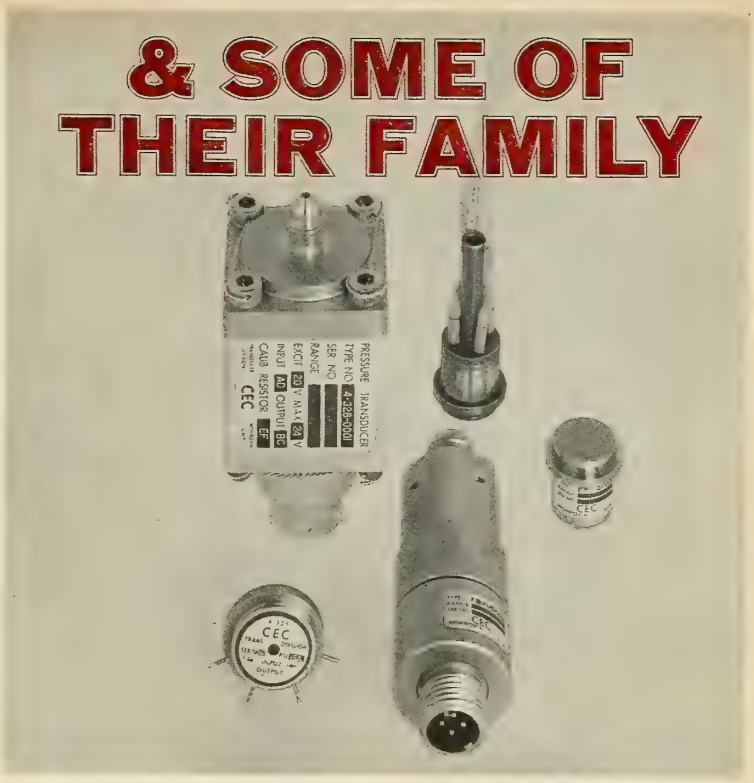
• **Light path resistance**—A function of light level and the inter-electrode area or, indirectly, light spot size. Light spot width must equal inter-electrode distance and is defined in terms of resistance per square unit of surface. Input resistance is between 10 and 50K ohms.

• **Breakdown voltage**—Breakdown voltage measured between any terminal and the case is in excess of 500 volts Rms. Insulation resistance using the same measurment method is more than 1000 megohms at 500 volts dc.

• **Power dissipation**—On the order of 10 milliwatts-maximum.

According to Giannini Controls Corp., the device "was not designed to replace inexpensive carbon film potentiometers. Although its applications are numerous, the photopot is currently best suited for instrument applications." ⌗

& SOME OF THEIR FAMILY



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Type 4-328 is the most sophisticated instrument yet developed for rugged airborne use in missiles – shunt-compensated, low-range (0-15 psi to 0-99 psi abs.)

Type 4-317 is ideal for high pressure measurement in high temperatures or nuclear radiation. Operates continuously, accurately at 600°F. Pressure ranges 0-100 through 0-5000 psig, psid.

Type 4-312, midget lightweight, is a workhorse. Pressure ranges 0-10 through 0-150 psia, psig, psid, ±5 through ±50 psi bidirectional differential.

Type 4-326, best for universal use, is operable in environments as rugged as 1000-g. Six models: –0001 Medium to High Range psia, psig; –0003 Low Range psia, psig; –0004 Low Range psid; –0005 Medium to High Range psid; –0008 Extra Corrosion Resistant; –0009 10-X overpressure protected.

Type 4-325, smallest of all (wt.: 8 gms.), can take temperature, vibration, acceleration, shock. Pressure ranges 0-10 through 0-100 psia, 0-2 through 0-100 psig, ±2 through ±50 psi bidirectional differential.

More data? Write now for Bulletin CEC 1308-X1.

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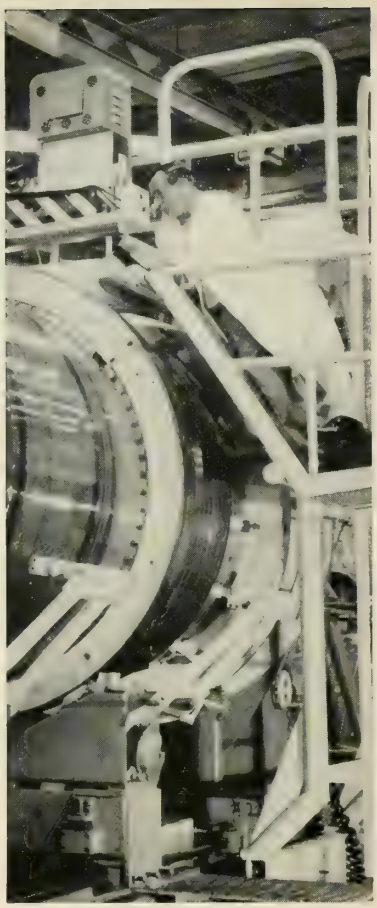
Foundry Capacity — Castings of aluminum and magnesium parts of intricate and precise design are a specialty at Wright Aeronautical. Facilities are complete for sand casting and shell molding.

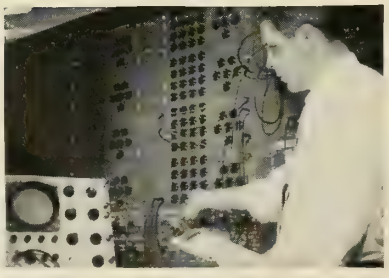


Space Age Welding — High-quality welding techniques convert steel sections into Minuteman rocket motor cases without use of preheat. Tooling is simplified, production increased and unit costs lowered.

Metallurgical Research — Hot sprayings of protective ceramic coatings on experimental missile cases is one of the advanced material techniques developed by metallurgists at Wright Aeronautical.

Spanning the Critical Demands of Industry Subcontracting

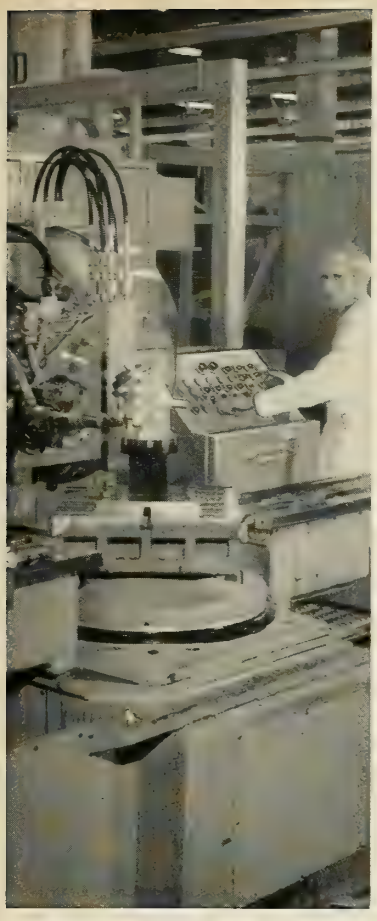
Total Capability



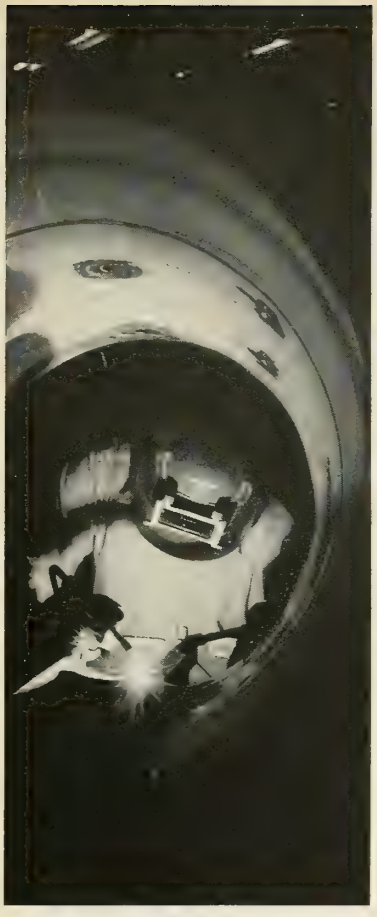
Engineering — Wright Aeronautical's experienced technical staff provides extensive engineering support to subcontracting programs, utilizing advanced analytical and computing devices to facilitate solution of complex problems.

Capability to design and manufacture aerospace products requires a wide range of technical skills which can also help virtually any branch of industry.

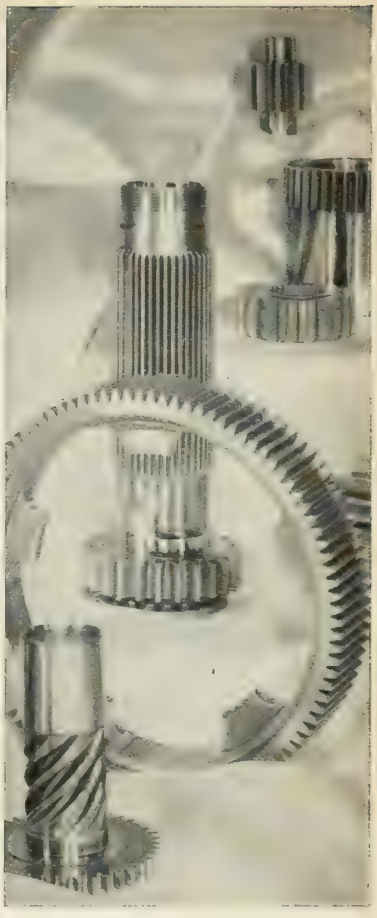
The complete facilities of the Wright Aeronautical Division provide a total capability in design, development,



Production Machining — Volume production of precision manufacturing to space-age standards of quality and precision is achieved by use of such equipment as this numerical tape-controlled machine.



Sheet Metal Fabrication — Precise forming, welding and fabrication of lightweight parts is made possible by experienced craftsmen using highly diversified and widely varied machines and equipment.



Gears and Gear-Systems — More than 50 million precision gears have been produced for defense and industry. A new Curtiss-Wright gear system increases electrical out-put of the Lockheed P2V aircraft by 50%.

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testing and manufacturing for many types of subcontracting work, from tiny gem-like gears to giant rocket motor cases. These integrated facilities are available either on a prototype or production volume basis, at competitive prices. Let us show you how our total capability will benefit your entire program.

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AF Building $1.7-million Simulator

by Heather M. David

CONTRACTING is rapidly proceeding on what will be one of the nation's most ambitious manned spaceflight research simulators.

At the Acceleration Section of the Biophysics Branch of the Aerospace Medical Research Laboratory, Wright-Patterson AFB, Ohio, work will begin this summer on the dynamic escape simulator—a device which combines centrifugal action with a number of other stresses of spaceflight.

The complex equipment—which will cost $1.7 million by the time it is completed—is scheduled to be operating by December, 1963. The centrifuge portion will be in service by December of this year.

Dyna-Soar and RS-70 profiles will be simulated on the new acceleration device, but it will also further Air Force capability in the field of acceleration and disorientation research.

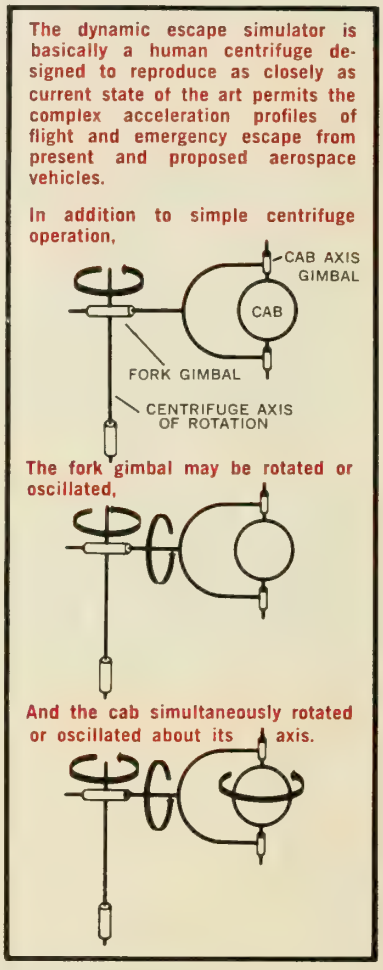
Major suppliers will be GE, The Breeze Corp., Compudyne Corp., Lucas-Rotax, Ltd., Moog Servocontrols and Process Equipment and Automation, Inc. Dr. Klaus L. Cappel, project engineer at the Franklin Institute, told M/R that many more contracts will be let.

• **Combined stresses**—The simulator will combine the functions normally carried out by a shake table, altitude chamber (up to 40,000 ft.) and a simple centrifuge. It replaces the old centrifuge at Wright-Patterson, the only AF capability for studying accelerations lasting more than 1 sec.

The earlier centrifuge, now 18 years old, has been redlined at 8 g's and will be phased out when construction of the new device begins. The old centrifuge was used in establishing re-entry tolerance levels for Project *Mercury* and in some portions of *Mercury* training.

The new device, designed and engineered by the Franklin Institute of Philadelphia, will be capable of applying forces up to 20 g's, with a rate of onset of 10 g's per second. In addition to the simple centrifuge action, a fork gimbal may be rotated or oscillated. The spherical cab may also be simultaneously rotated or oscillated about its axis.

With the main arm at rest, the platform can be moved through six degrees of freedom—three translational (x, y, z axes) and three rotational (roll, pitch and yaw).


The dynamic escape simulator is basically a human centrifuge designed to reproduce as closely as current state of the art permits the complex acceleration profiles of flight and emergency escape from present and proposed aerospace vehicles.
In addition to simple centrifuge operation,
CAB AXIS GIMBAL
CAB
FORK GIMBAL
CENTRIFUGE AXIS OF ROTATION
The fork gimbal may be rotated or oscillated,
And the cab simultaneously rotated or oscillated about its axis.

INTERCHANGEABLE cabs add versatility.

Maximum pitch oscillation is 38°, roll is 20° and yaw is 3°. The cab drive provides oscillations in yaw from 3° to 360°.

Vibrations may be produced up to 15 cycles per second. Complex tumbling patterns may be simulated, since the capsule may be rotated up to 30 rpm and 150 rpm in the cab and fork axes respectively, with maximum payload.

The shake table will handle a payload at maximum use of 500 lbs. With a 10-g centripetal force, gimbal performance will accommodate a payload of 1000 lbs.

The overall centrifuge arm will be 24 ft. This relatively short length (Johnstown's centrifuge is near twice as long) limits the use of the centrifuge as a flight simulator, since the short arm rotation will cause subjects to suffer the coriolis effect. Hence the name dynamic escape simulator—it still can be an excellent tool for simulating the tumbling and buffeting of emergency escape and re-entry.

• **Unprecedented** — These escape patterns—with high-speed tumbling, oscillations, vibrations and repeated decelerations due to the deployment of drogues, reefed parachutes and de-reefing, etc.—can be studied individually and then sequentially. As described in a recent presentation, "this dissection of escape events through time will, for the first time, allow the accelerations derived from instrumented dummy aircraft ejections to be identified and tested under controlled conditions, and the more serious challenges characterized and modified."

The centrifuge arm to the cab will be 19 ft. Cab outside diameter will be 10 ft. This large volume will make it possible to locate the subject so that the axes of rotation will intersect his head at any selected point, making it a disorientation research tool "equal to the world's finest device for this purpose."

The acceleration section at the Aerospace Medical Laboratory is designing several different types of restraint systems so that subjects can be positioned in a number of different ways.

• **Interchangeable cabs** — Another outstanding feature of the device is that the use of several interchangeable cabs will enable researchers to instrument cabs for a variety of experiments while the machine may already be in use. This will greatly increase the useful time of the machine, say ASD representatives.

There will be about 150 slip ring channels for information and power to the cab. This will permit complete bioinstrumentation of the subjects, and elaborate performance tasks. ASD spokesmen point out that this is three times the slip-ring capacity of the present Aerospace Medical Laboratory centrifuge. ⁂

IF THIS INSERT, ENTITLED "AEROSPACE GROUND EQUIPMENT AND SYSTEMS CAPABILITY" HAS BEEN REMOVED, WRITE FOR ADDITIONAL COPIES TO: DIRECTOR OF MARKETING, GENERAL DYNAMICS | CONVAIR, P. O. BOX 1950, SAN DIEGO 12, CALIFORNIA.

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AEROSPACE GROUND EQUIPMENT AND SYSTEMS CAPABILITY

From design through engineering and manufacturing, Convair has proven capabilities in handling aerospace ground equipment programs. Under subcontract to General Dynamics | Astronautics, Convair was assigned engineering tasks on the Atlas "D," "E" and "F" series, Centaur, Atlas target for Nike-Zeus, and Atlas booster for Mercury, Samos, Agena and Able-5 programs. In addition, Convair is prime contractor for design and packaging of the IR radiometer and associated instrumentation in the nose cone of the Black Brant Space Probe. These and the following achievements are evidences of Convair's ability to integrate its extensive resources with design and production of the most complex aerospace systems.

(right) These models of AMR Complex 36A were built to assist Convair engineers in the planning and investigation of launch complex facilities for launch control, instrumentation, and closed-circuit television.

LAUNCH CONTROL SYSTEMS

Under a subcontract from General Dynamics/Astronautics, Convair has been responsible for design and development of the new Atlantic Missile Range (AMR) Complex 36A, design and modification of AMR complexes 11, 12, 13 and 14, and Sycamore Canyon test sites S-1 and S-2. Since 1959, Convair engineers have gained valuable experience through the responsibility for research and development of the Atlas program missile and space booster launch control. This responsibility included modification of launch and static firing sites to handle operational series missiles.

(below) These AMR 13 Atlas "E" series launch control consoles are typical of those which Convair engineers have designed or modified for AMR complexes 11, 12, 13, and 14, and Sycamore Canyon complexes S-1 and S-2. System design included all of the electrical control and distribution, starting from the facility power source, through logic assemblies, to the missile umbilical, LO_2, and fuel tanking, pressurization and pneumatic interfaces. Major considerations were given to system integration, calibration, validation, and actual manufacture and site installation.

SIGNIFICANT TASKS ACCOMPLISHED

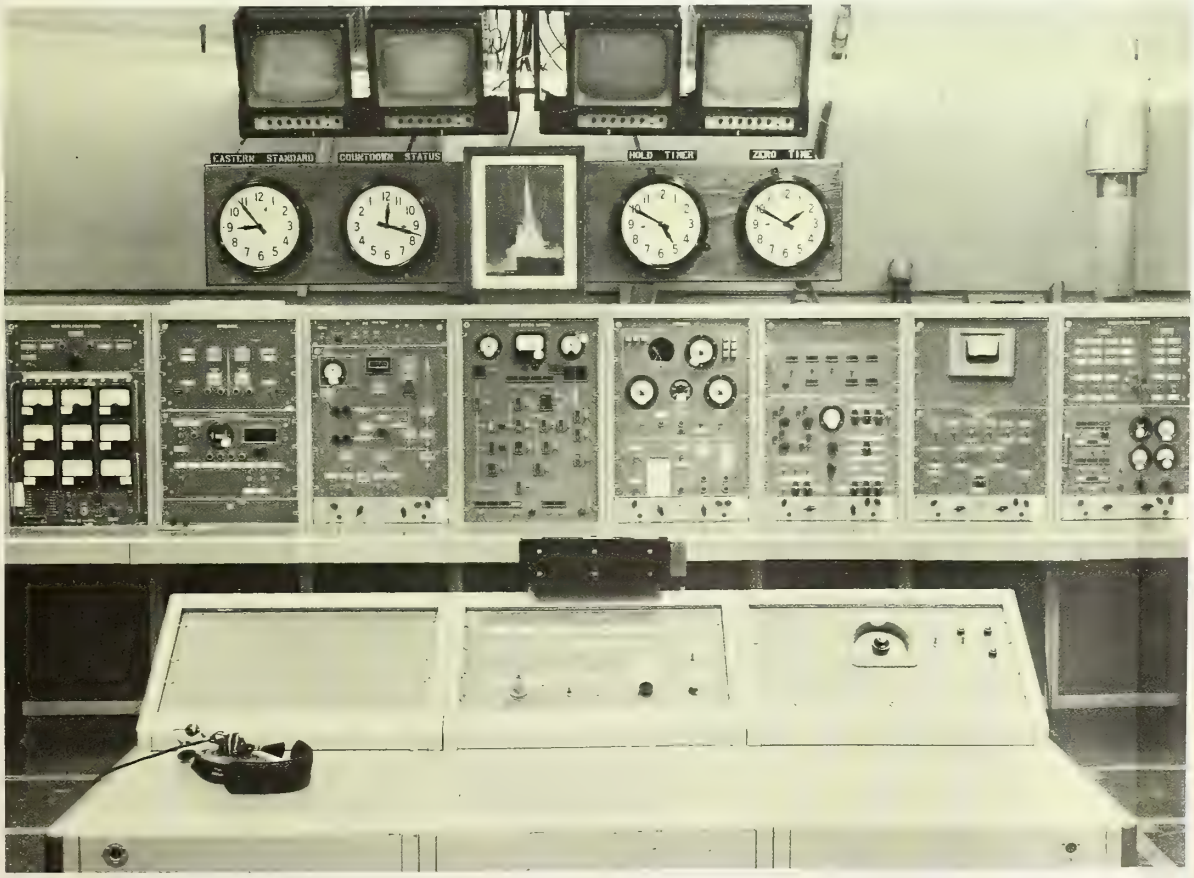
SYCAMORE CANYON COMPLEX S-1: Convair accomplished a complete system and subsystem integration of the Silo "F" series automatic launch system with the "F" series R&D manual and semi-automatic logic. This required a complete interface of operational equipment, without change, to allow switchover from R&D to Silo and return at any point in a full Atlas countdown, including engine static firing and shutdown.

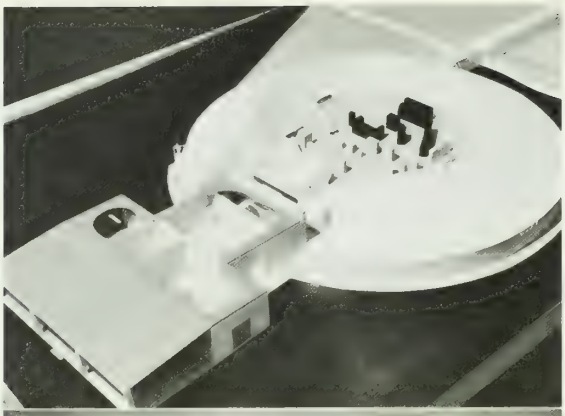
AMR 13: Modified by Convair engineers to handle a basic Atlas space booster with an Agena second stage and a satellite payload. For the first time in the Atlas program, the use of techniques of modular logic was required, and IBM-type system programming on patch panels and self-testing and calibration units were integrated into the launch control system, resulting in a reduced pad-time-per-launch.

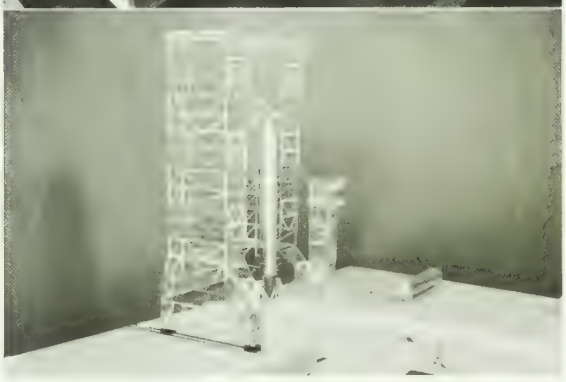
AMR 14: Modified by Convair to accommodate Atlas/Mercury program.

AMR 11: In modifying this complex to handle the Atlas "E" and "F" series missiles, Convair's task included integration of mobile automatic-programmed checkout equipment (MAPCHE).

AMR 12: Modified by Convair to handle space probe of the Ranger configuration.







(below) This mobile instrumentation trailer was designed by Convair to permit on-site receiving of telemetry signal and recording on magnetic tape for quick-look data processing with readout on direct-writing oscillographs or on pen and brush recorders.

ENGINEERING FOR MISSILE SPACE BOOSTER INSTRUMENTATION AND DATA ACQUISITION

Some of the major problems in missile and space exploration programs are the acquisition of large quantities of data within a short time span, reduction of this data within allowable tolerances, and the wide range of data required. Convair has solved many of these problems, on a subcontract basis, in support of the Atlas missile and space booster program.

The landline instrumentation systems for Atlas complexes at AMR 36A and Vandenberg Air Force Base (OSTF I and PALS I) were designed by Convair. These systems include digital tape, FM tape, oscillographs, null balance and brush recorders. They are integrated to permit continuous, five-point calibration and patch programming for quick changeover to prevent loss of data. A complete closed-circuit television system was designed for OSTF I.

These launch complex instrumentation systems are indicative of Convair's extensive experience in construction and operation of telemetry facilities. The telemetry receiving stations are capable of recording, calibrating and programming to provide a flow of data to analog and digital computers in the proper format to obtain full-plot, calibrated data ready for engineering use.

Vehicle systems investigation for airborne instrumentation systems on the Centaur, Propulsion Test Vehicle and Environmental Test Tank, coupled with extensive assistance on Atlas "E" and "F" series missiles, has resulted in engineering which establishes measurement requirements, actual transducer selection and installation design. This combination of ground and airborne systems engineering has established a broad base of understanding for the overall problems of data acquisition, vehicle systems integration, static firing and launch.

(right) AMR 36A blockhouse, showing Atlas launch control consoles (left) and Centaur launch control consoles (right). Convair engineers designed, developed and installed the Atlas launch control and instrumentation systems.

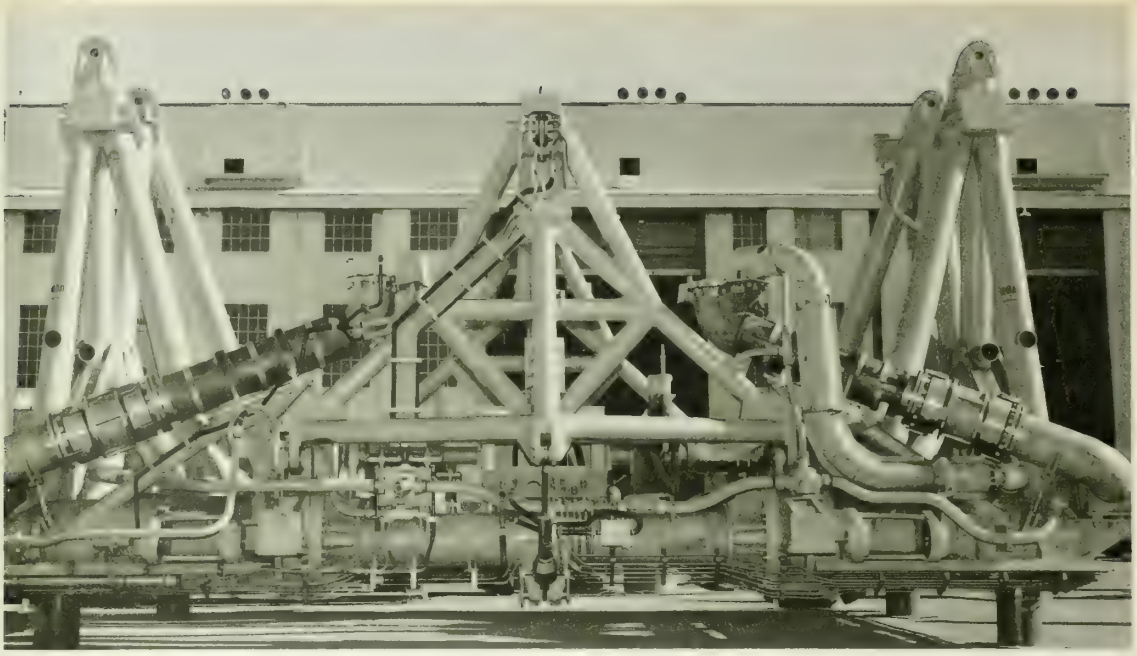
GENERAL DYNAMICS | CONVAIR

AEROSPACE GROUND EQUIPMENT AND SYSTEMS CAPABILITY

Convair-designed aerospace ground equipment and systems are presently in operation at missile sites and at military and commercial aircraft installations throughout the world, fulfilling their tasks with the accuracy and dependability required in the aerospace age.

Convair's experience in the field of missiles, its extensive manufacturing facilities and engineering capabilities are available for subcontract tasks, to assist major contractors with their aerospace ground equipment programs.

GIIIIIIID



GENERAL AEROSPACE SYSTEMS

Subcontract tasks awarded to Convair for the design and development of the following aerospace ground equipment and systems have received the attention of an engineering team recognized throughout industry for its accomplishments:

Design and construction of Atlas "D" and "E" series launchers.

Design and construction of nitrogen-cooled LO_2 supply and storage units.

Installation of launch control equipment and cables for operational Atlas missile sites.

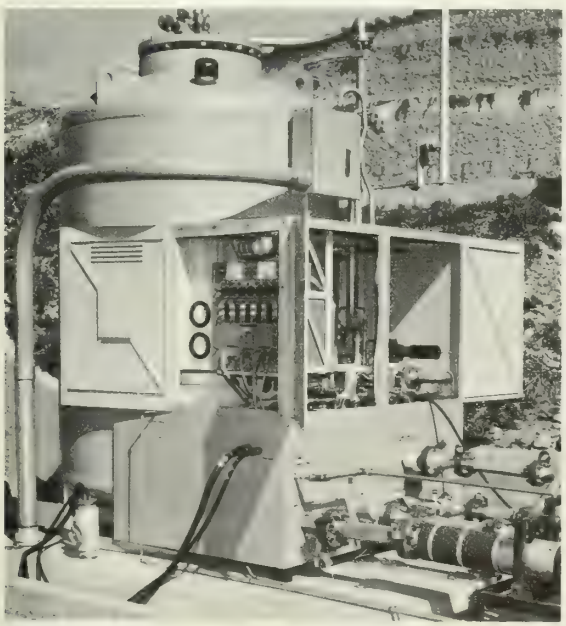
Base liaison activities at operational training and research and development sites.

Test equipment programming, validation, and operation.

Preparation of activation, validation and integration procedures.

(above) Design of the launcher for the Atlas "D" and "E" series missiles required extensive Convair engineering in the fields of heavy structures, mechanisms, heat exchangers, high-pressure hydraulic and pneumatic systems, and the development of new shielding and welding techniques. This launcher is used to load the missile, support it in shock-mounted readiness, pivot it to firing attitude, and retain it during engine run-up prior to release. The launcher also contains provisions for servicing of missile systems and for missile disconnect.

(illustrated on front cover) Typical R&D missile and space booster AMR complex built by General Dynamics for Atlas and Centaur programs.



(left) Complex cryogenic supply and storage units, such as this liquid nitrogen-liquid oxygen unit for the Atlas missile, can be developed for any aerospace program by Convair.

ADDITIONAL INFORMATION

Convair is a long-time supplier of varied products and services to both military and commercial customers. Located in San Diego, Calif., Convair is adjacent to major sea, air, and rail transportation facilities. For subcontract tasks, Convair offers a vast complex of engineering and manufacturing area — covering 5 million square feet of enclosed floor space and 5 million square feet of paved outdoor work area usable throughout the year. All of the company's facilities and experienced personnel are available for subcontract tasks.

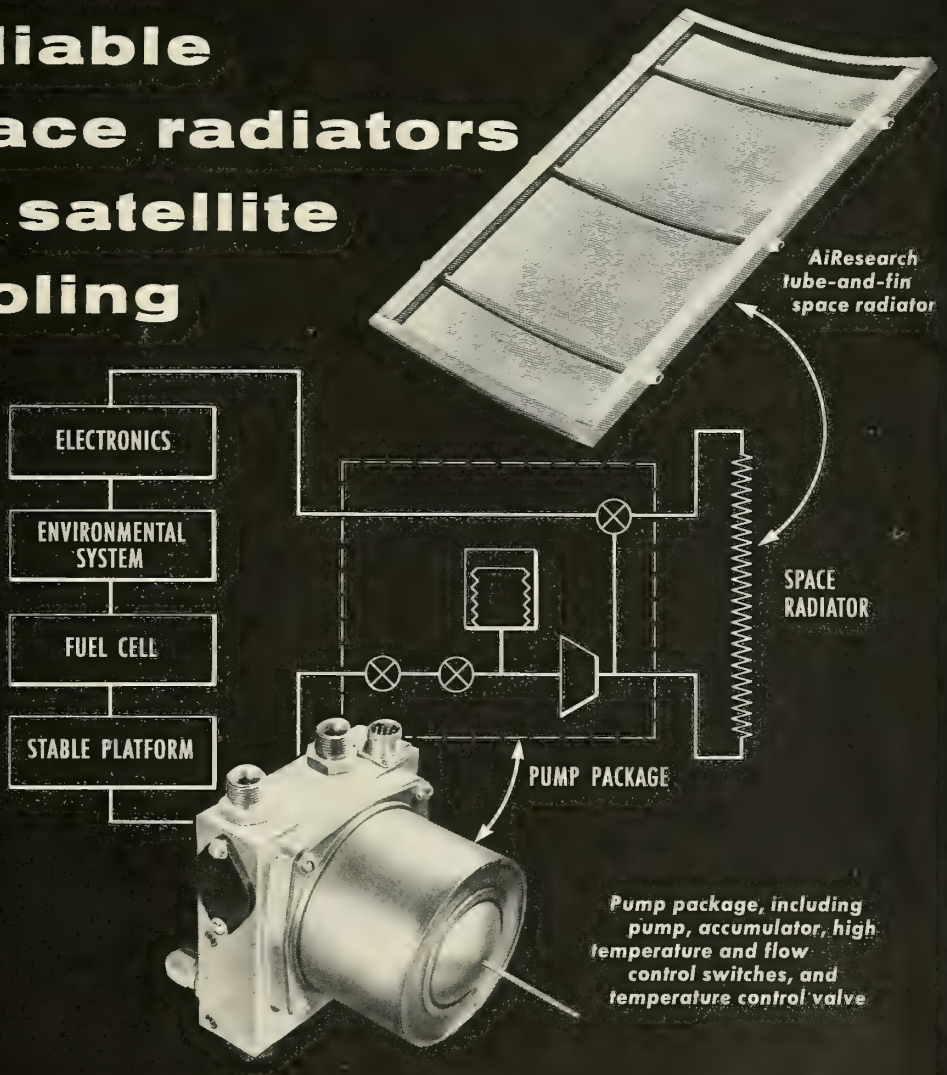
In addition to aerospace ground equipment and systems, Convair capabilities include: Machine Shop • Sheet Metal Fabrication • Tool Manufacturing • Scotchweld Bonding • Honeycomb and Metal Bond Manufacturing • Plastic Parts Production • Titanium Fabrication • Experimental Manufacturing and Processing • Manufacturing Support (welding, heat treating and processing, manufacture of rivets, tubing and cables, electrical harnesses). All areas of activity are supported by Quality Control • Applied Manufacturing Research and Development.

To obtain companion folders describing any of the above capabilities, please contact:

Director of Marketing
General Dynamics | Convair
Department MR-2
P.O. Box 1950
San Diego 12, California

GENERAL DYNAMICS | CONVAIR

Reliable space radiators for satellite cooling



Garrett-AiResearch has designed, fabricated and tested lightweight space radiators, utilizing proven hardware concepts throughout. Active radiator systems can cool electronic equipment, fuel cells, stable platforms and environmental systems operating from 400°F to cryogenic temperatures.

AiResearch is foremost in space radiator design and manufacturing, and is highly experienced in weight optimization techniques, meteoroid protection, transient temperature analysis, fabrication techniques and emissive coating characteristics.

Present AiResearch space radiator development and production programs include systems for both manned and unmanned space vehicles. Other types of space heat transfer experience include the Project Mercury and Dyna-Soar systems.

AiResearch has more than 20 years of experience in the design, development and manufacture of heat transfer equipment for aircraft, missiles and space vehicles. Your inquiries are invited.

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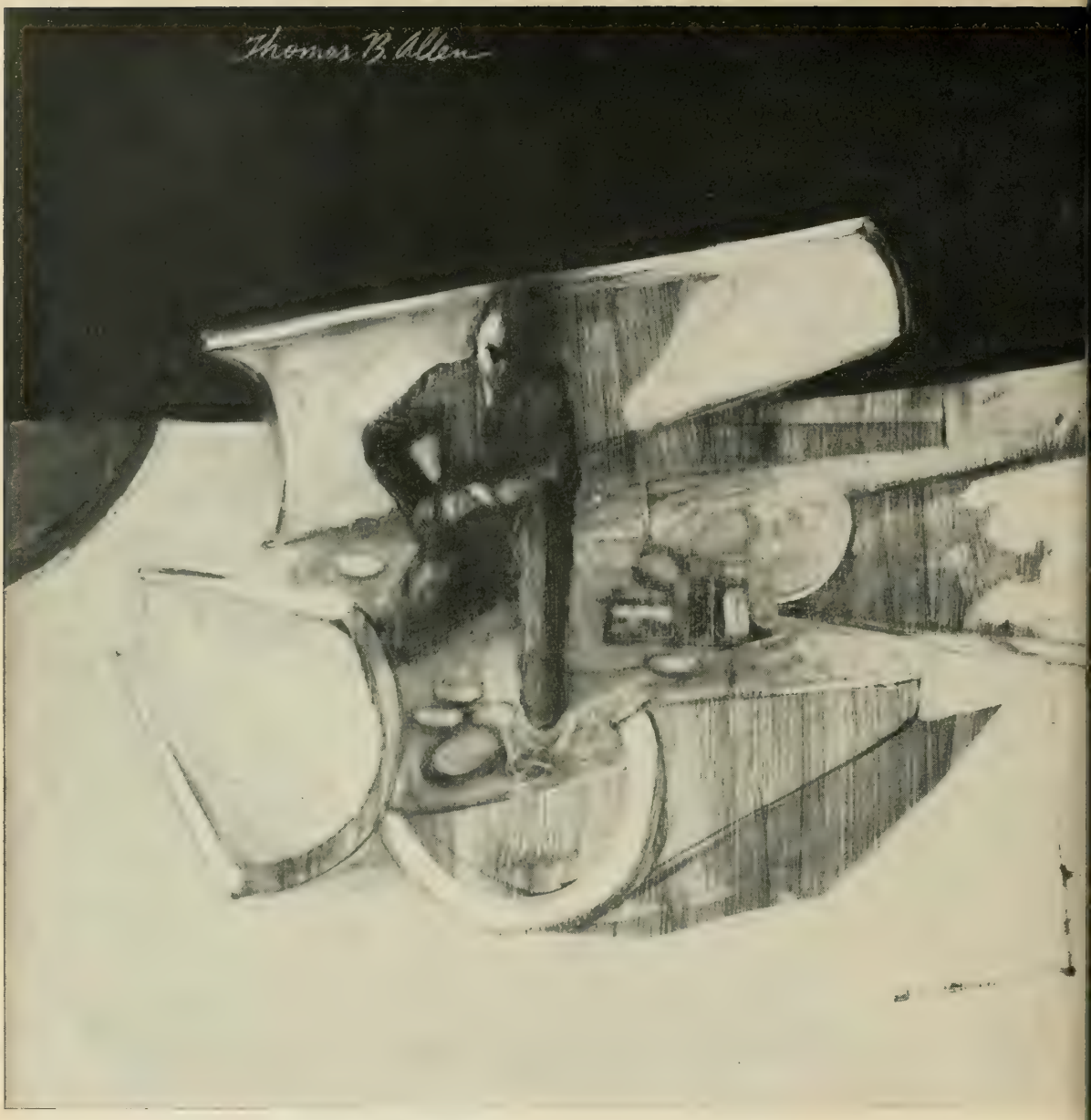


THE SKEPTICAL MEN

"...habits," wrote John Dryden, "gather by unseen degrees,—
As brooks make rivers, rivers run to seas."

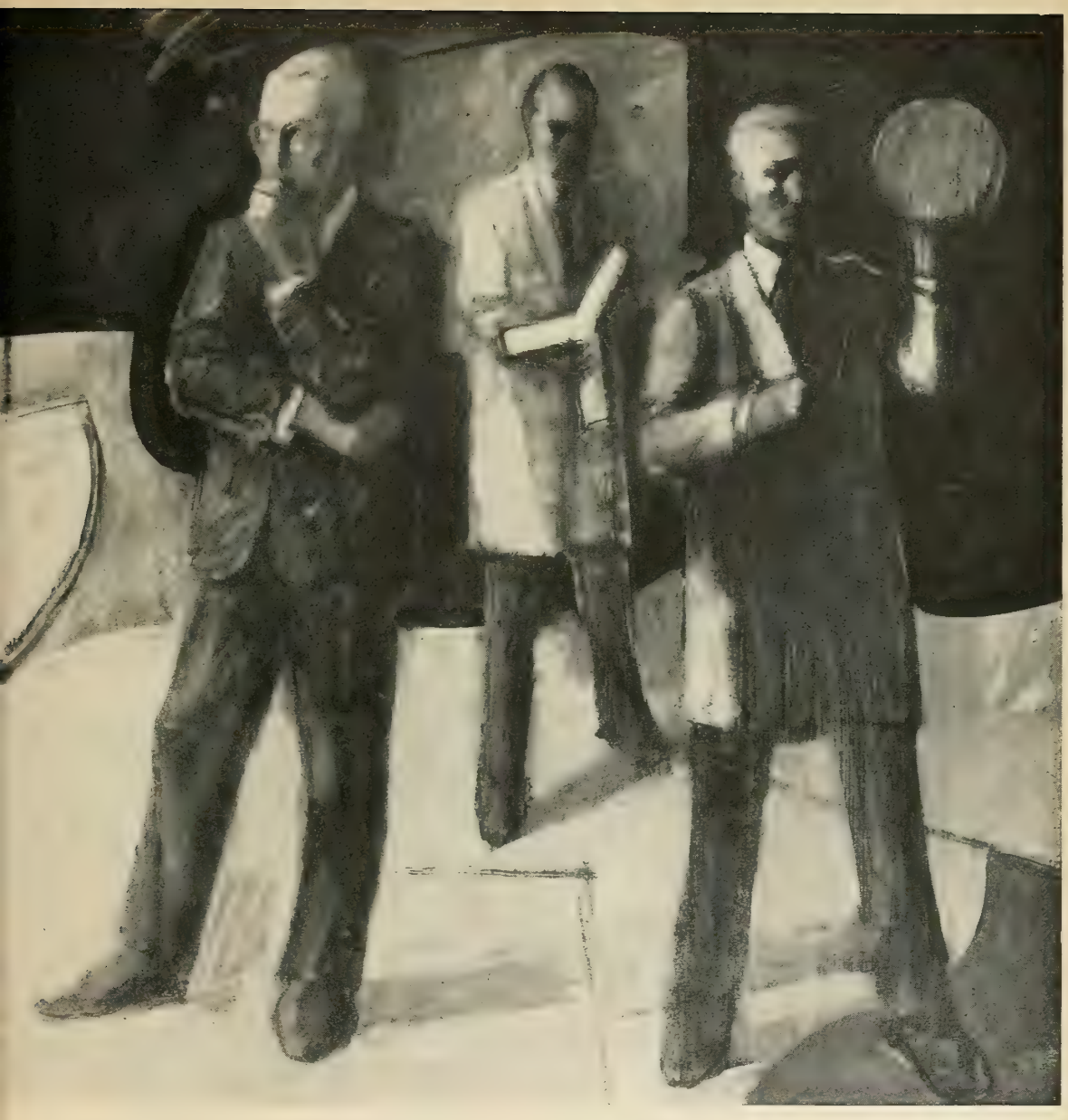
All men are susceptible to the accumulation of habits. It's a natural part of our lives to do things with a certain repetition.

But in industry, accepted ways of doing things, based merely on repetition, can prove expensive.

Because of the complexity of projects carried out by the aerospace industry, it has been looking with increased skepticism on accepted methods of doing things. As a result there have arisen whole new approaches within management—approaches fulfilled by men in value analysis, quality control, product reliability.

These men, working together, and working closely with engineers and purchasing agents, help cut needless expense while maintaining and increasing high levels of reliability.

Some of the questions they ask are: "What is the item?" "What is the function?"



"What does it cost?" "What else would do?" "What would that cost?"

Questions such as these may sometimes make their work difficult in the area of human relations, but as the scope of the work is better understood these problems decrease. For this new approach is more than just mere cost consciousness. It is a highly creative method that allows management to overcome roadblocks of pre-conceived ideas.

Analysis of function is now spreading to every level of production—from top management to the design engineer to the purchasing agent to the man on the line.

This is one of the ways the aerospace industry is helping America get the most for its defense and space money. It has already paid off in millions of dollars saved.

This is the work of men who are not willing to accept the accepted.

This is the work of the skeptical men.

North American Aviation is at work in the fields of the future through these six divisions: Atomics International, Autonetics, Columbus, Los Angeles, Rocketdyne, Space & Information Systems

Was Titov Hypnotized During Flight?

by Dr. Hallack McCord
University of Colorado

RUSSIA may have hired two Indian yogis to teach USSR cosmonauts how to achieve a yoga-like trance for spaceflight.

This report emerged from a survey of experts on hypnotism who were polled on their opinions on use of hypnotism for spaceflight.

One psychiatrist theorized that Gherman S. Titov was in a hypnotic trance during his flight. Evidence pointing to this is the fact that he was able to sleep eight hours during what must have been a rigorous and exciting flight. In addition, Titov has been quoted as saying "We Cosmonauts had been trained by physicians to fall asleep instantly, when desired, and to wake up exactly at a given time."

A number of advantages of hypnosis were listed by those polled. They include:

• Ability to withstand reduced sensory input. Considerable concern has been shown about the human organism's ability to function "really alone" for prolonged periods. It was felt that hypnosis offers a means of offsetting this condition.

• Improved eidetic memory. It has been felt that distortion of the time sense through hypnosis might render astronauts better able to remember details of their flights. Hypnosis would help them to recall each sensation.

• Improve intellectual efficiency. Some respondents felt it might be worth experimenting on the use of hypnosis to improve human speed and accuracy, especially in mental activities such as mathematics. One expert suggests hypnosis could turn a man into a "lightning calculator."

• Autogenic training—a specialized method of relaxation training.

• Heightened capacity to withstand impacts. Opinion has been elicited that hypnosis could condition persons to weather falls, shocks and accelerations.

• Reduced boredom—the astronaut could hallucinate pleasurable things.

• Thermal tolerance, controlled metabolic activity. The astronaut could be taught to control his automatic nervous system and increase his tolerance to heat and cold, and control his heart and pulse rate.

• Tranquilization — Hypnotism could be used to handle various feeling states and sensations such as giddiness, vomiting and claustrophobia. In a like manner, the astronaut could induce his own sleep.

• Relief of discomfort. It could aid the astronaut in maintaining uncomfortable positions for prolonged periods of time.

• Aid in selection—Certain personality diagnosis functions could be performed with potential astronauts while they were hypnotized.

• Creation of "real" simulation. Potential astronauts could be hypnotized to believe they were actually in a space cabin. This would aid the training program a great deal, as well as provide a tool for selection.

• Counteraction for unpleasant effects of weightlessness. Although not enough is known about weightlessness to make possible a concrete suggestion, hypnotism would be a good tool to counterpart any psychological effects of weightlessness.

• Passing time—Hypnotism could be appiled to distort time.

Almost every one of the 32 experts who formed the basis of the opinions is an official of one of three groups 1) The International Society for Clinical and Experimental Hypnosis, 2) The American Society of Clinical Hypnosis, 3) The Society for Clinical and Experimetal Hypnosis. Membership in these groups generally requires a doctor's degree in medicine, psychology or dentistry and several years' specialty experience in hypnosis. ⌗

First SAC Titans

(Continued from page 17)

tiveness of the complex is the ultra-high-speed Propellant Loading System. The PLS, designed and engineered by Arthur D. Little, provides for storage and rapid transfer of liquid oxygen, liquid nitrogen, gaseous nitrogen and helium.

Command guidance system for *Titan I* was manufactured by Western Electric Co.

Bell Telephone Labs performed basic research, development and design of the system.

Heart of the tracking system is the Athena guidance computer, developed by Remington Rand Univac, which compares tracking data on position and speed with a predetermined stored trajectory. Solid-state design of the computer has reduced its size considerably.

All phases of engineering, development, production, installation and checkout of the intra-site communication system were handled by General Dynamics/Telecommunication.

Essentially a specialized central telephone system, the setup consists of dial telephones, direct-line telephones and associated switching equipment, explosion-proof maintenance networks and an all-area public address system.

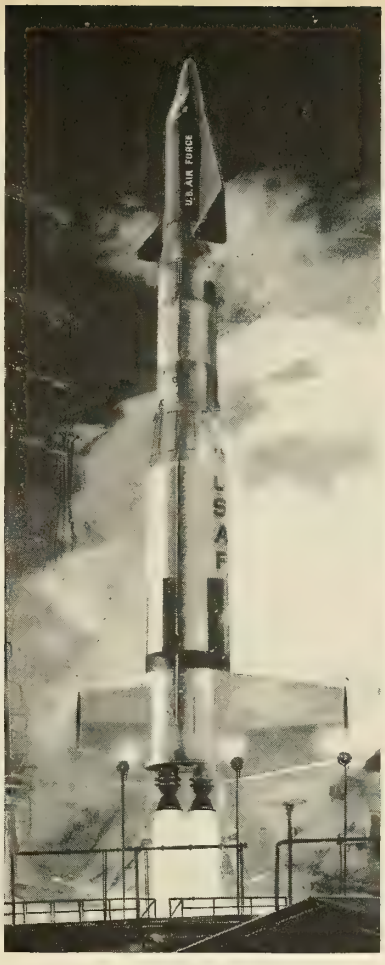
Systems engineering on the complex was carried out by Space Technology Laboratories, Inc. Daniel Mann Johnson and Mendenhall was responsible for architectural engineering.

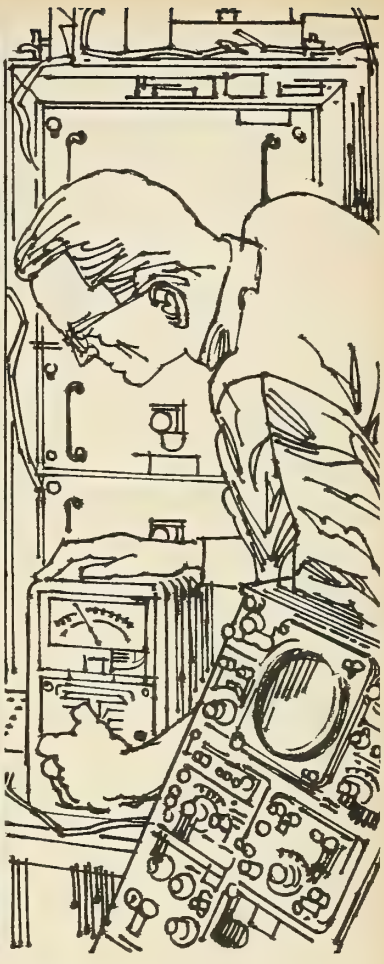
Both stages of the *Titan I* are powered by Aerojet-General liquid rocket engines. Mark 4 re-entry vehicle on the missile was designed and built by Avco Corp.

• **Buildup gains steam**—Cost of a fully-equipped *Titan I* squadron, including missiles and ground support equipment but not including research and development costs, is placed at $200 million by Maj. Gen. Thomas P. Gerrity, commander of the Ballistic Systems Division. He estimates total cost of the nation's full ICBM force will be $15½ billion.

Activation of the two underground *Titan* squadrons at Lowry will bring the number of operational U.S. ICBM's to 72, including three *Atlas* training missiles at Vandenberg AFB which are counted in the inventory.

Activation of six *Atlas F* squadrons and the six *Titan I* squadrons will nearly triple this number by the end of this year. Phasing in operationally of *Titan II* and *Minuteman* will result in well over 500 ICBM's on operational status by the end of 1963. A total force of 1031 is now planned, including 200 *Minuteman* not yet funded. ⌗





Advanced-program openings at Boeing for

STRUCTURAL AND ELECTRONIC/ELECTRICAL ENGINEERS

Boeing's Aero-Space Division, holder of major contracts on such advanced space programs as SATURN, DYNA-SOAR and MINUTEMAN, has a number of immediate, long-range openings offering professional challenge, and in many instances, unique ground-floor opportunities in newly-formed divisional organizations.

STRUCTURAL engineering openings require knowledge of the air loads, high heating rates, extreme differential temperatures, material oxidation and creep associated with advanced vehicles designed for flight regimes ranging from orbital to normal landing speeds.

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Salaries are commensurate with all levels of education and experience. Minimum requirements are a B.S. degree in any applicable scientific discipline. Most of the assignments are in the uncongested Pacific Northwest, offering outstanding family living and recreational advantages.

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The Industry Week

NAA Apollo Subcontractor Reps

North American Aviation plans to station resident representatives of its Space and Information Systems Div. at plants of the major subcontractors on the *Apollo* program. Clarence Nelson, *Apollo* Material Manager, says the resident representatives will serve as liaison subcontract managers, heading S&ISD Subcontractor Management Offices at each company. These offices in some locations also will include representatives from *Apollo* engineering and quality assurance departments. First five NAA representatives are: Collins Radio Co., Steve Hamilton; Marquardt Corp., Jack Thompson; Minneapolis-Honeywell, William Van Valkenberg; Pratt & Whitney, Hugh Toczek; AiResearch Manufacturing Co., Marvin Currey. Nelson said other representatives will be named shortly for other *Apollo* subcontractor firms.

Corporate Division Changes

Douglas Aircraft established a *Skybolt* subdivision within the company's Missile and Space Systems Div. The *Skybolt* unit will be directed by J. L. Bromberg, former chief project engineer for *Thor,* program manager for *Nike-Zeus,* and director of programs for all the company's military and government programs. . . . *General Precision, Inc., established an Aerospace Group to design and produce complete guidance and control systems for space and defense projects. The Aerospace Group will consist of a new Aerospace Systems Div., the Kearfott Div. and a new Aerospace Research Center. President is Fred D. Herbert, Jr., vice president and director of General Precision Equipment Corp. and president of Kearfott Div. The group is at work on a major contract—assignment from BSD to develop a stellar-inertial guidance system.* . . . Planning Research Corp. formed a Nuclear Engineering Section to study advanced nuclear power systems for space, remote land, and underwater applications.

New Industry Facilities

Lockheed Propulsion Co. purchased a 9000-acre tract in Southern California for manufacture and testing of solid-propellant rocket motors. Company President Robert F. Hurt said "our plans call for a major new space center to arise here. We have already completed construction this week of a static test stand capable of handling solid motors six times more powerful than the Atlas. . . ." The purchase brings to over 12,000 acres the land owned by the company in two California counties, and is part of a company plan to gear facilities and operations to development, production and check-out of large solid boosters. . . . Detroit Gasket and Manufacturing Co. opened a new facility in Newport, Tenn., for production of compressed asbestos gasketing. . . . *Clevite Electronic Components, a Clevite Corp. division, plans to more than double production capacity at its Bedford, Ohio, plant with construction of a $1-million addition, scheduled for completion in August. The expansion is designed to meet increasing demand for piezolectric ceramics.* . . . Steel Improvement and Forge Co., Cleveland, purchased Air Force Plant No. 41, consisting of three buildings, 15 steam forging hammers and supporting equipment. . . . *Babcock Electronics Corp. continues to expand its Costa Mesa, Calif., facilities. Latest acquisition is a new 10,000-sq.-ft. building bringing total facilities to five times the firm's Costa Mesa holdings five years ago.* . . . Raytheon Missile & Space Div. put into operation a space environment simulation system capable of duplicating environmental conditions 800 miles above the Earth. . . . *Baldwin-Lima-Hamilton Corp., Burnham, Pa., began construction of a new metallurgical building to provide office and conference areas for an enlarged technical staff.* . . . Instrument Systems Corp. broke ground for a 44,000-sq.-ft. plant in Hicksville, *N.Y.* . . . *Richmont Torque Tools, Monrovia, Calif., moved its sales, administrative and manufacturing facilities to Houston, Tex.* . . . Pacific Automation Products, Inc., completed an expansion program increasing company production capacity for the aerospace cable market by 50%.

New Names in the Industry

American Hofmann Corp. has been formed to market Hofmann electronic dynamic balancing machinery in the United States. It is jointly owned by Astlett and GEBR Hofmann KG, Darmstadt, West Germany . . . *Opcalite, Inc., has been formed in Los Angeles as a wholly-owned subsidiary of Oppenheimer Plastics, Inc., to serve the parent company's West Coast customers. Oppenheimer does human factor engineering and produces integrally lighted instruments, panels and data presentation displays for electronic and aerospace applications* . . . Thermel, Inc., changed its name to Elmwood Sensors, Inc. . . . *Elgin National Watch Co. changed the name of its Abrasives Div. to Precision Div., to reflect diversification of division activities* . . . Electro Sheet Metal Corp. was formed in Paramount, Calif., as a wholly-owned subsidiary of Cahn Instrument Co.

News of Mergers and Acquisitions

Aerotest Laboratories, Inc. acquired an 80% interest in Propellant Systems, Inc. active in the field of high-energy fuels and oxidizers and in design of associated thermodynamic and mechanical equipment. PS will operate as a subsidiary of the lab . . . *Robins Industries Corp. purchased the filter manufacturing business of the Great Eastern Filter Corp. and its affiliates, Brooklyn, N.Y.* . . . Quantic Industries, Inc., San Carlos, Calif., acquired Technoproducts, Inc. to complement the company's Pelmec Div. activities in development and manufacture of such aerospace devices as ramjet and rocket engine ignitors, arming units and separation systems . . . *Booz, Allen Applied Research Inc. acquired Designers for Industry, Inc., Cleveland.*

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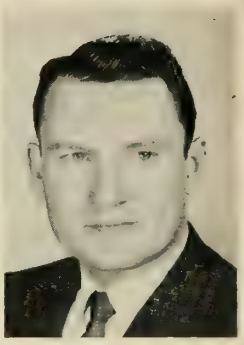


KENNA

John R. O'Brien: Appointed a vice president of Hoffman Electronics Corp., to handle corporate relations with the military and other government agencies in Washington, D. C.

Terence R. Gregory: Elected president and director of DATA-tronix Corp., Norristown, Pa., a new company producing telemetry components and systems. He was formerly a vice president and general manager of the TELE-datax Div., Sonex, Inc.

Edward J. Sheehy: Named manager of Hercules Powder Co.'s "Manned Flight Booster Program." Prior position was assistant manager of ABLs Rocket Research Div.

Dr. John F. G. Hicks: Named vice president of Battelle Memorial Institute. A chemist by profession, he joined the Institute a year ago after leaving Corning Glass Works, where he was vice president.

Walter Doll: Named nuclear systems manager of Pratt & Whitney Aircraft. **C. E. Holtsinger, Jr.,** was selected as nuclear systems assistant manager.

John W. Fiske: Appointed director of product planning for Corning Glass Works. He will be responsible for coordinating research and marketing functions.

Alexander Satin: Joined General Precision, Inc., as Director of Long-Range Planning, a new position involving development of future plans for space and defense business. Satin is a member of the MISSILES AND ROCKETS Advisory Board. He has been Senior Scientific Advisor with Lockheed Aircraft and Chief Engineer and Staff Consultant for ONR.

Dr. Hugh Dryden: NASA deputy administrator, was awarded the Langley Gold Medal of the Smithsonian Institution, given for "specially meritorious investigations in connection with the science of aerodromics and its application to aviation." It was awarded Dryden in recognition of his "important applications of experimental science to the problems of flight and for his wise and courageous administration of much of America's research and technical developments that now make possible the conquest of air and space." The award has been given only nine times since its establishment in 1908. The first recipients were the Wright brothers in 1909. Later, it was awarded to Glenn Curtiss, Gustave Eiffel, Charles Lindbergh, Charles M. Manly, Richard E. Byrd, Joseph Ames, Jerome Hunsaker and Robert H. Goddard.

J. L. Bromberg: Appointed Missile and Space Systems Div. vice president-director of *Skybolt* Program, Douglas Aircraft Co. He had been assistant general manager of the division.

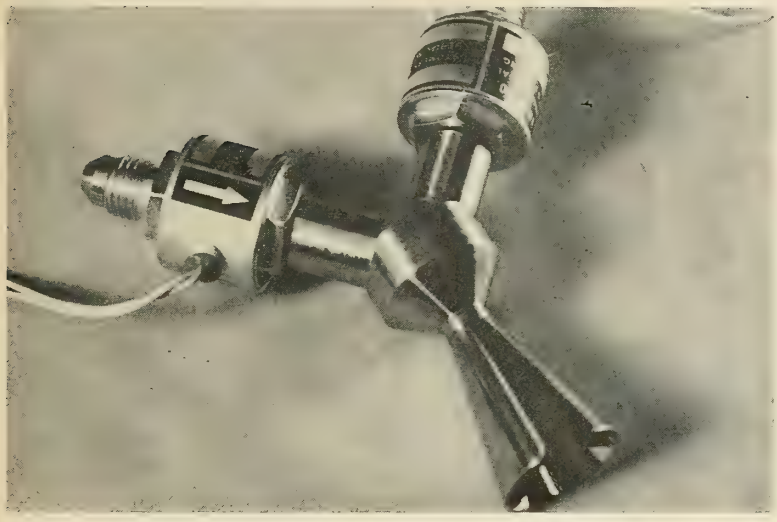
Richard C. Sorensen: Named president of Tracerlab, a Div. of Laboratory For Electronics, Inc. and the Keleket X-Ray Corp., and LFE subsidiary. He joined the company in 1957 as production manager.

Dr. Bernard Herzog: Appointed Director of the Space Sciences Lab of Philco Corp.'s Western Development Labs. He will direct studies in physical phenomena and techniques relating to space technology.

Dr. D. L. Slotnick: Appointed manager of advanced data processing systems for Westinghouse Air Arm Div. He will be responsible for studies, design and development in advanced computer organization, exploratory systems and computer technology.

E. Douglas Kenna: Appointed vice-president and general manager of Avco Corp.'s Research and Advance Development Div., Wilmington, Mass. Also appointed were **Dr. Jack A. Kyger,** vice president and assistant general manager, and **Dr. Mac C. Adams,** vice president and technical director.

Everett A. Prechel: Appointed director of corporate and contracting policies, Hughes Aircraft Co. He had been manager, contracting policies, since joining the company in 1959.



New Product of the Week: 0.01-lb.-Thrust Microrocket

THE MODEL R-10-2G, available from Rocket Research Corp., has a thrust of 0.01 lb. and a delivered vacuum specific impulse of 300 sec. The propellants, chlorine trifluoride and monomethylamine, are stored as liquids but injected as gases. Design philosophy is intended to achieve a low-weight system with higher reliability than the nitrogen jet system by eliminating high-pressure gases and pressure regulation devices. Only moving parts in the Model R-10-2G are the valves. No propellant bladders are required. The radiation-cooled thrust chamber and valves weigh less than 1/5 lb. Length, excluding valves, is 2⅛ in.

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Frequency Multiplier

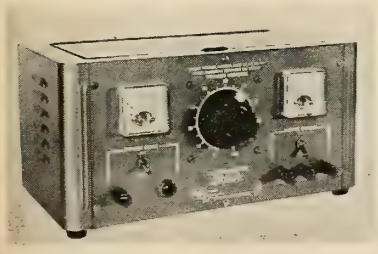
Applied Research Inc., announces the availability of a high-efficiency varactor frequency multiplier. An output of over 250 milliwatts is delivered in the 1800 to 1935 mc band, with an input of 500 milliwatts at 600 to 656 mc.

Circle No. 226 on Subscriber Service Card

DC Power Supply

A high-current power supply with adjustable output voltage for industrial and laboratory use has been announced by Kidde-Electronics Laboratories. Walter Kidd & Co. Inc.

Designed for applications where close regulation is not required, it is especially useful in transistor circuit development work. Its low ripple and wide range of output voltage as well as high output current also makes the unit well suited for most laboratory requirements.



Circle No. 227 on Subscriber Service Card

Clip-on Nut

A clip-on nut has been developed by the Kaylock Div., Kaynar Mfg. Co. Major uses include electronic packaging where close quarters preclude riveting and modular consoles where choice of nut spacing is desired and where requirements necessitate changes in nut spacing.

Circle No. 228 on Subscriber Service Card

Electric Vaporizer

An electric vaporizer has been developed by Cal-Val Research and Development Corp. for the vaporization of any liquified gas.

Advantages include absence of moving parts, immediate generation of gas at desired temperature (to 500°F), and prevention of gas contamination that may be caused by heat transfer fluid.

The vaporizer can connect to any commercial or industrial power source without the addition of intermediate or switching equipment, and can be built in a variety of sizes from models that generate approximately 5000 SCFH to units that will provide in excess of 200,000 SCFH.

Circle No. 229 on Subscriber Service Card

Broadband Crystal Switch

AEL, Inc. has developed a broadband VHF-UHF crystal switch which covers the frequency band from 20 Mc to 1000 Mc with an insertion loss no higher than 3.5 db and typically less than 2.0 db over most of the band. The isolation varies from over 32 db at 20 Mc to approximately 27 db at 1000 Mc.

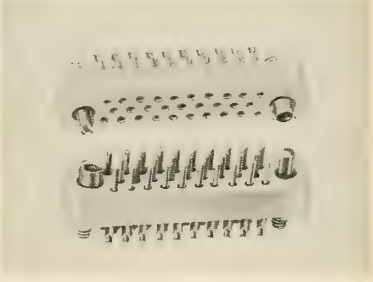
Typical applications for this switch include antenna lobing, TR switching, RF chopping, modulation, and channel switching.

Circle No. 230 on Subscriber Service Card

Precision Connectors

U.S. Components has introduced its UMI series of Ultra-Miniature precision connectors for an almost infinite variety of applications.

Available in 11 standard sizes with 5, 7, 9, 11, 14, 20, 26, 29, 34, 44 or



50 contacts accommodating up to No. 22 AWG wire they are supplied in standard draw-pull and screwlock units, molded in glass-filled Diallyl Phthalate meeting MIL-M-19833.

Circle No. 231 on Subscriber Service Card

Magnetic Amplifiers

Military & Computer Electronics Corp., has designed a magnetic amplifier with specifications wide enough to accommodate full production tolerances, and to conform to quality control system per MIL-Q-9858. These

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SPECIAL REPORT ON PROJECT APOLLO

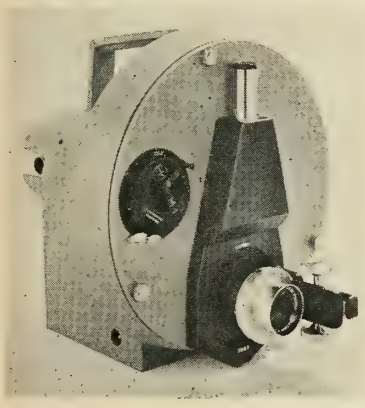
Issue Date: May 21, 1962 Advertising Closing Date: May 7, 1962

amplifiers provide up to 43db polarity reversible gain with zero stability better than 1%. The units have an overload capacity of 1000% and are highly resistant to radiation. Power requirements are 115v. (±10%) on a 60 cps scource. Range of operating temperature is from −10°F to +180°F and storage temperatures range from −60°F to +180°F.

Circle No. 232 on Subscriber Service Card

Oscilloscope Camera

A special high-speed drum-type camera, Model 364, has been developed by Beckman & Whitley particularly for



application to the oscilloscope recording of high-speed non-periodic waveforms. The lens focusing range is from 10 in. to 3 ft., accomplished by a reflex-viewing eye piece. It is driven by a ⅞ hp motor rated at 120 v, 60 cps; and operating speed is controlled by a built-in variable transformer.

Circle No. 233 on Subscriber Service Card

Resistivity Probe

Micro State Electronic Corp. has announced the availability of a four-point probe. The device is designed to measure bulk resistivity and diffused and epitaxial layer sheet resistance in production control, research and development of semiconductor devices. The detachable head containing the probe is mounted on a two-directional micromanipulator for ease in positiong the probes on the wafer to be measured. Banana jack connections are conveniently located for insertion of measuring equipment.

Circle No. 234 on Subscriber Service Card

Strain Gage Amplifier

Natel Engineering Co., Inc. is marketing a Model 9036 Strain Gage Amplifier. The completely transistorized unit uses a sine wave excitation circuit

that makes it possible to utilize longer lines in instrumentation systems without compensating for line capacitance. In addition, changes in frequency of the excitation voltage cause no unbalance in the transformer-coupled amplifier. The unit operates at ambient temperatures from —55°C to 71°C.

Circle No. 235 on Subscriber Service Card

Thermistors

Gulton Industries, Inc., has available thermistors in wafer, disc, washer, rod and bead configurations. They are supplied in resistances from 1 ohm to 1000 megohms and in a range of temperature coefficients of resistance from −3.4% per degree C. to −6.8% per degree C.

Circle No. 236 on Subscriber Service Card

An important position is available in our propulsion section for an individual with experience in compressible flow and advanced aerodynamics. Knowledge of boundary layer characteristics is desirable but not essential. Work will be in the following areas and will be both analytical and experimental in nature.

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- Pneumatic devices using aerodynamic elements without moving parts.

internal aerodynamicists

Since this group has been a leader in the fluid-injection thrust-vector-control field since 1950, it is obvious that the work will be of a highly advanced nature. Similarly, research in the supersonic inlet area has been in progress since 1948.

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AIR FORCE

$36,536,000—**Thiokol Chemical Corp.**, Brigham City, Utah, for continued research and development for the Stage I *Minuteman* motor, through flight test and qualification test (supplemental contract).

$11,374,000—**Martin Marietta Corp.**, Denver, for work on site activation of operational *Titan* bases and for *Titan I* ground operating equipment (two supplemental contracts).

$10,200,000—**General Motors Corp.**, Milwaukee, for production of inertial guidance systems for *Titan II*.

$7,000,000—**North American Aviation, Inc.**, Downey, Calif., for production of *Minuteman* guidance and control systems (supplemental contract).

$5,583,966—**North American Aviation, Inc.**, Downey, Calif., for spare parts for *Minuteman* guidance and control systems (supplemental contract).

$5,378,000—**Philco Corp.**, Palo Alto, Calif., for work on a satellite control program.

$2,000,000—**Lockheed Aircraft Corp.**, Sunnyvale, Calif., for work on a classified project.

$1,836,866—**United Aircraft Corp.**, East Hartford, Conn., for a weather observing and forecasting system (supplemental contract).

$1,795,294—**North American Aviation, Inc.**, Canoga Park, Calif., for applied research for liquid rocket engine propellants.

$1,550,000—**Aerojet-General Corp.**, Azusa, Calif., for work on space boosters.

$1,471,500—**McDonnell Aircraft Corp.**, St. Louis, for fabrication and testing of re-entry vehicles (supplemental contract).

$1,682,000—**Douglas Aircraft Corp.**, Santa Monica, Calif., for development of a capability for production of an air-to-air rocket fuze (supplemental contract).

$1,200,000—**International Telephone & Telegraph Corp.**, New York City, for antennas and related equipment (letter contract).

$1,194,982—**Martin Marietta Corp.**, Orlando, Fla., for production of *GAM 83* missile trainers and related items.

$1,178,257—**General Dynamics Corp.**, San Diego, Calif., for launch and related services for *Atlas* space boosters at Point Arguello, Calif.

New Ameray Tongs cost only a few hundred dollars,* but they perform many jobs as well as manipulators with price tags in the thousands. Ameray Tongs feature **continuous-locking action** and **parallel-motion jaws** for positive safety. ■ Straight-line mechanical designs and hydraulic articulated models are available. Mock-up of mechanical model shown above. ■ Write or call today for your FREE Tongs File Folder.

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$1,000,000—**Lockheed Aircraft Corp.**, Sunnyvale, Calif., for equipment for *Agena* space vehicles.

$333,190—**United Technology Corp.**, Sunnyvale, Calif., for research in non-destructive testing techniques for large solid-propellant rocket motors.

NAVY

$4,296,123—**Sperry Rand Corp., Ford Instrument Div.**, Long Island City, N.Y., for fire-control-system computers.

$1,500,000—**Lockheed Aircraft Corp.**, Sunnyvale, Calif., for *Polaris* A3/FPV functional proofing vehicle and *Polaris* As/A-M active-inert vehicles (letter of intent).

$1,136,800—**Ling-Temco-Vought, Inc.**, Dallas, for utilization of KD2U-1 target drones and teams to operate them.

$225,000—**Columbia University**, New York City, for research in oceanography and underwater accoustics with emphasis on bottom and sub-bottom characteristics.

ARMY

$19,300,000—**Martin Marietta Corp.**, Orlando, Fla., for additional power station simulators for *Pershing* and system modification and repair parts (three contracts).

$3,156,171—**Paul Smith Construction Co.**, Orlando, Fla., for alterations to Complex 13, Cape Canaveral Missile Test Annex.

$1,995,000—**Food Machinery & Chemical Co.**, San Jose, Calif., for 75 missile carriers for the *Pershing* missile.

$1,150,000—**General Electric Co.**, Syracuse, N.Y., for repair parts of HIPAR guidance radar for *Nike-Hercules*.

$1,000,000—**Lear, Inc., Electro-Mechanical Div.**, Grand Rapids, Mich., for control surface actuators on the *Sergeant* missile.

$424,055—**Hayes International Corp.**, Birmingham, Ala., for *Pershing* type X warheads and the *Pershing* missile components (two contracts).

$190,000—**Graham Contracting Inc.**, Orlando, Fla., for construction of an aircraft and weapons building addition and for radar tower utilities at Cape Canaveral.

$109,564—**D. J. Dermody Co., Inc.**, and **Ralph Welker, Inc.**, Lancaster, Calif., for *Titan II* trainer facility at Vandenberg AFB, Calif.

DOD

$24,970,057—**Boeing Co.**, Seattle, for development of the *Minuteman* weapons system, bringing total funding to $501,082,501.

$450,000—**Thompson Ramo Wooldridge, Inc.**, Los Angeles, for assistance in the design of an advanced computer-supported damage assessment center.

NASA

$12,000,000—**Aerojet-General Corp., Space Propulsion Div.**, Azusa, Calif., for manufacture of the service module propulsion engine for the *Apollo* spacecraft.

$1,000,000—**EPSCO, Inc.**, Cambridge, Mass., for development of a data collection and analysis system for pre-launch checkout of satellites.

$174,000—**Electronic Communications, Inc.**, St. Petersburg, Fla., for follow-on production of flight control computers for use in the *Saturn* program.

Bell Aerospace Corp., Hydraulic Research and Manufacturing Co., Downey, Calif., for the hydraulic servo actuator assembly for the *Advanced Saturn* second stage. Amount undisclosed.

AEC

Martin Marietta Corp., Nuclear Div., Baltimore, for a nuclear generator to power an experimental navigational beacon at the bottom of the Atlantic Ocean. Amount undisclosed.

INDUSTRY

$1,000,000—**Perkin-Elmer Corp.**, Norwalk, Conn., from **AC Spark Plug Div. of General Motors Corp.**, for the manufacture of azimuth alignment theodolites for use with the *Titan*.

$500,000—**Ets-Hokin and Galvan, Inc.**, San Francisco, from **Boeing Co.**, for maintenance of the communications cable network servicing the Montana *Minuteman* wing.

$250,000—**Hughes Aircraft Co.**, Newport Beach, Calif., from **Bendix Corp.**, for production of crystal filters for use in the *Talos* missile.

Westinghouse Electric Corp., Baltimore, from **McDonnell Aircraft Corp.**, for radar for the *Gemini* spacecraft. Amount undisclosed.

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RE-ENTRY & SATELLITE HEAT TRANSFER ANALYSIS PhD, MS, BS. Analysis and development of thermal design criteria.

ESTABLISH DESIGN CRITERIA PhD, MS, BS. For hypervelocity space vehicles, hypersonic re-entry vehicles.

PREDICT RE-ENTRY THERMAL PROTECTION PROBLEMS PhD, MS, BS. Predict and develop protective concepts for various superorbital, satellite and aerospace vehicles.

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PROPULSION SYSTEMS — DESIGN STUDIES MS, BS. Conduct theoretical and experimental cycle investigations; develop advanced propulsion concepts integrated into vehicle design of rockets, hypersonic airbreathing vehicles.

CRYOGENIC RESEARCH MS, BS. Study problems of liquid hydrogen fuel tanks for hypervelocity space vehicles.

ALKALI METALS — CHEMICAL RESEARCH MS, BS. Investigate problems of compatibility at elevated temperatures of alkali metals with various materials.

ANTENNA DESIGN MS in Physics or EE. Design and development of antennas for re-entry vehicles. Knowledge of window effects and general re-entry radiation blackout problems.

ELECTRONIC INSTRUMENTATION BS, MS. Develop instrumentation for space vehicles. Knowledge of system integration and telemetry highly desirable.

OTHER STIMULATING POSITIONS OPEN TO ENGINEERS with BS or better. Space environmental testing of vehicles; aerospace propulsion systems; aerospace applications of statistics to vehicle design; structural analysis; thermal protection analysis; gas dynamics; wind tunnel testing; aerospace hydraulic and pneumatic systems; advanced manned vehicle propulsion systems; aerothermodynamic evaluations of re-entry vehicles.

Interested applicants are invited to write in confidence to Mr. George R. Hickman, Technical Employment Manager

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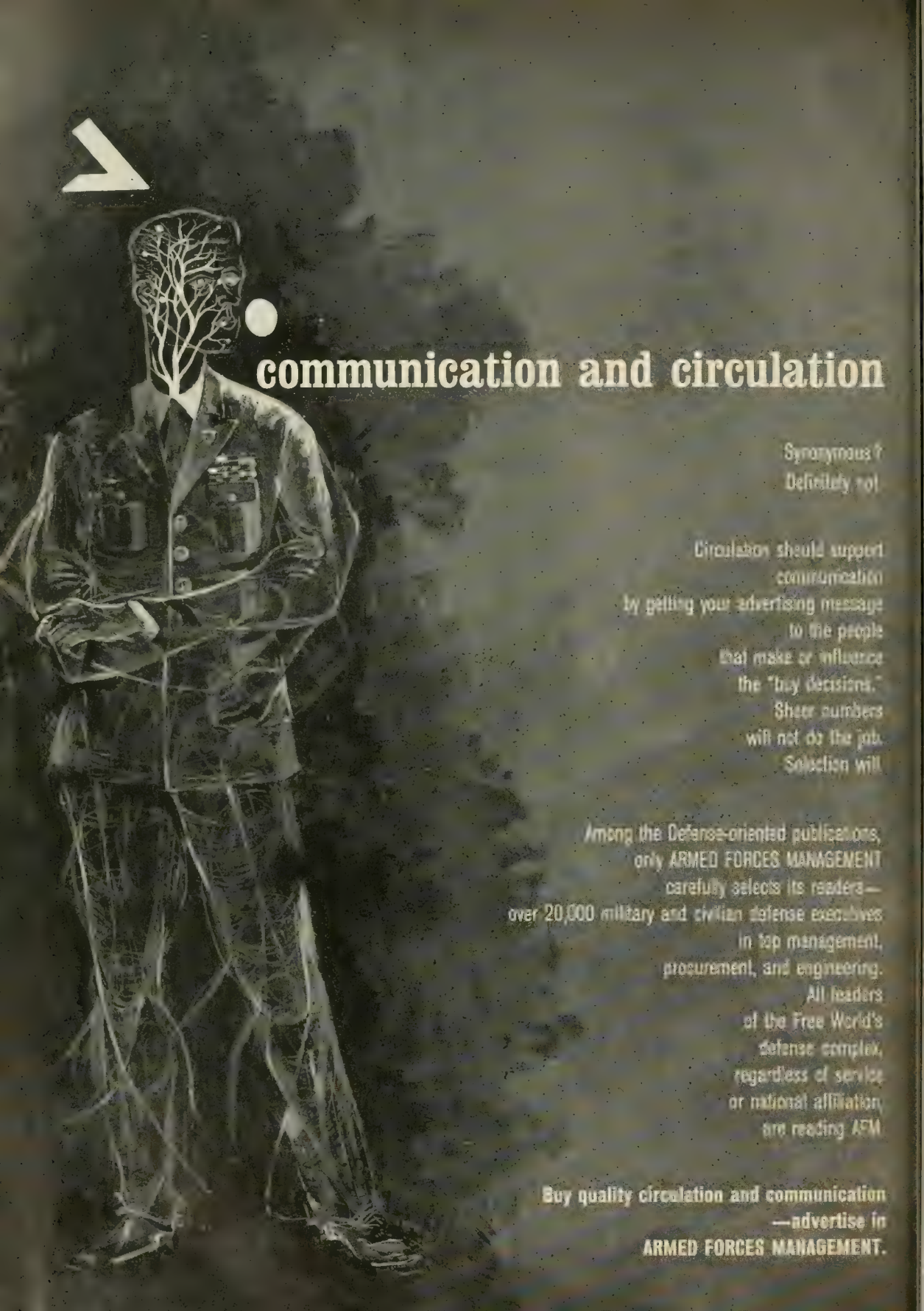

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The Dividends from Space

LAUNCHES IN THIS PAST WEEK, both Soviet and American, have emphasized the quickening pace of activity in the space field. Progress of *Ranger* on its moonward flight was viewed with interest by the industry teams at work on the *Apollo* spacecraft—which will follow *Ranger* to the moon.

In a busy factory at Downey, Calif., a number of initial mockups of the command and service modules of the *Apollo* craft are being rushed to completion by North American Aviation.

Yet the vast gap in knowledge which must be quickly spanned within the next few years is emphasized by the black headlines in the news racks just outside the plant entrances: "Ranger Is Only a Partial Success." Important components of the spacecraft have failed to function.

The lunar mission of the three-man spacecraft will tolerate no such failings. Perfection must become commonplace.

But, primitive though it may be in comparison, the *Ranger* spacecraft is the first American contact with the alien lunar surface—an accomplishment unthinkable a few years ago except in the pages of science fiction.

It raises once again the perennial cry of anguish among the timid of pocket—"Why are we spending such vast sums to go to the moon?"—and the wail of terror among the timid of heart—"Why don't we stay at home in front of our television sets as God intended?"

John Paup, North American's *Apollo* program manager, has one answer: Because it is something we must do. "We would go if there were no Russians," he says.

FOR THE PRAGMATIST, however, this is never sufficient answer. Where, he demands, are the benefits?

As background information for the Second National Conference on Peaceful Uses of Space, to be held next week in Seattle, a survey of civilian dividends from space research has been made by Edward Gottlieb & Associates, Ltd., of New York.

This comprehensive report, based in part on a special survey of companies engaged in space research and development, is emphatic proof of the benefits which our pragmatist is getting for his dollar.

Let's take a look at some of this civilian fallout:

• Pressurized space suits developed by B. F. Goodrich Co. are making it possible for bedridden victims of strokes to walk and work.

• Space research by General Data Corp. has resulted in restoration of hearing of deaf persons, by means of a surgical implant of a tiny electronic device.

• X-ray equipment developed by Aerojet-General Corp. for examination of *Polaris* rocket motors makes it possible to produce X-ray photos at only 1/30th the previous radiation exposure.

• Kollsman Instrument Corp. is carrying out research which indicates lasers may be used for coagulation in brain surgery, as well as in eye tumor removal and retinal welding.

• As a result of space experimentation with algae, Boeing Co. has developed a process for making flour of high nutritive value.

• American Machine and Foundry Co. believes a better coffee is coming due to development of a new Teflon-coated cloth filter designed for use in space research.

• IT&T reports that ultraviolet phototubes developed for space probes may be effective flame detectors in a home alarm system.

• Hoffman Electronics Corp. is manufacturing a portable radio powered by solar cells originally designed for spacecraft power.

• Sundstrand Aviation has developed a photochromic material for space use which may lead to adaptable sunglasses and anti-glare windows.

• Packard Bell Electronics has developed a ceramic insulation material to withstand the extreme heat generated by exotic rocket fuels. It is being used in high-temperature applications in the civilian atomic energy program.

• Daystrom, Inc., developed a metal film precision resistor for space use which is now being employed commercially in analog computers.

• Techniques and subcircuits developed by Collins Radio for space communications are being applied to new commercial FM transmitters.

• Texas Instruments semiconductors developed for space are finding their way into civilian markets in radios and industrial computers.

THESE ARE but a few examples. The ultra-high-speed drill which makes your dentistry less painful may depend upon tiny ball bearings developed for satellite equipment. The football helmet your son wears may have been improved by shock tests based on space telemetry. The canned food you eat may be better because of infrared techniques developed in space research.

More accurate measurement of the time you live by, more accurate forecasts of the weather you live in, more widespread knowledge via television of the world you inhabit—all can be traced to benefits from the space program.

Vice President Lyndon Johnson pointed out at the recent Goddard Dinner in Washington that the entire space program is costing less annually than the $5 billion the nation spends on face powder, lipstick and nail polish.

Which is worth more? Cosmetics or the cosmos? There can be only one answer.

William J. Coughlin

SCIENTISTS AND ENGINEERS:

Today the men of Motorola's aerospace team are applying creative mindpower to the analysis, design, construction and test of advanced space communications command and control systems. Vital contributions are being made to such important current NASA programs as the Goddard cis-lunar Range and Range Rate Tracking System... the JPL Mariner and Ranger unmanned planetary and lunar probes... and updating of the Deep Space Instrumentation Facilities to "S-band" for JPL. If you are interested in shaping the future with a dynamic aerospace contractor on these and other programs, we can offer immediate opportunities to both System and Equipment Design Engineers. Write us today describing in detail your experience in the following areas of aerospace technology:

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